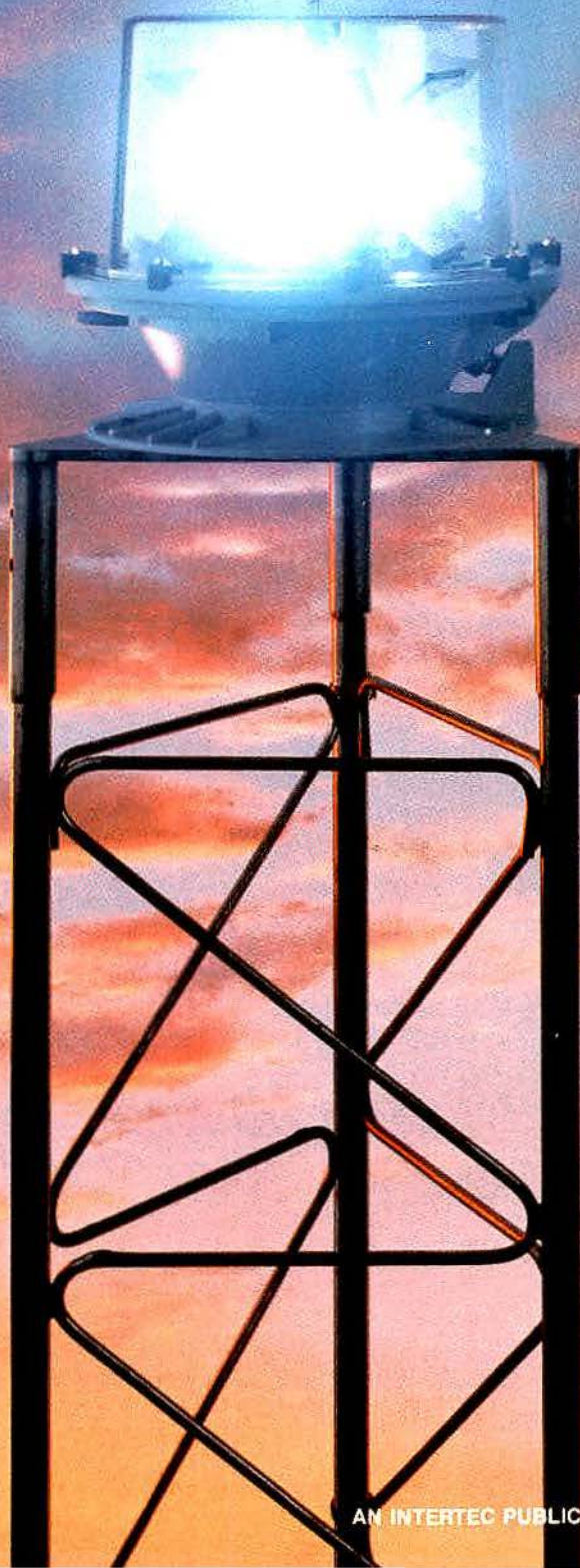


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Mobile Radio Technology

The journal of mobile communications technology

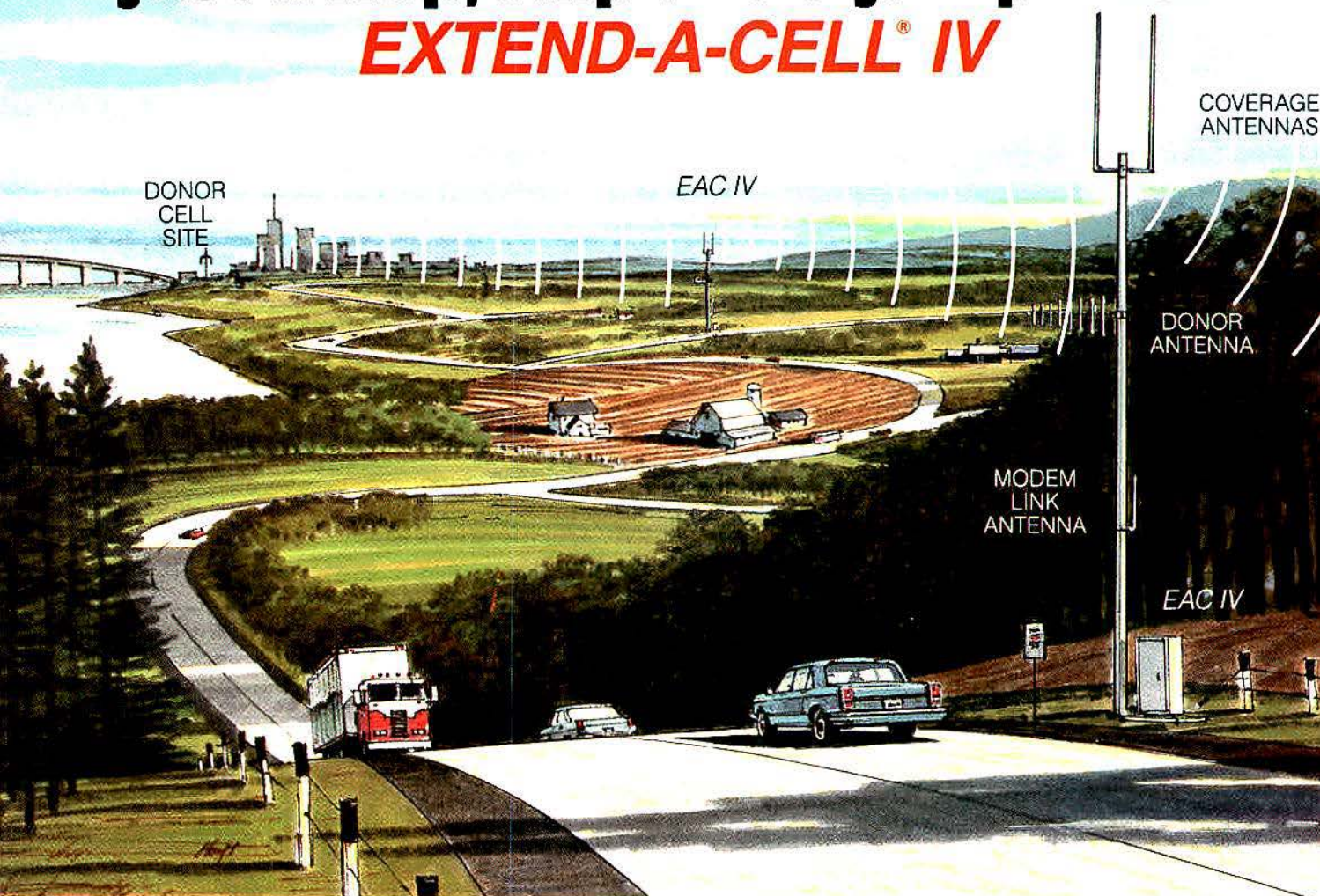


Tower lighting, p. 10

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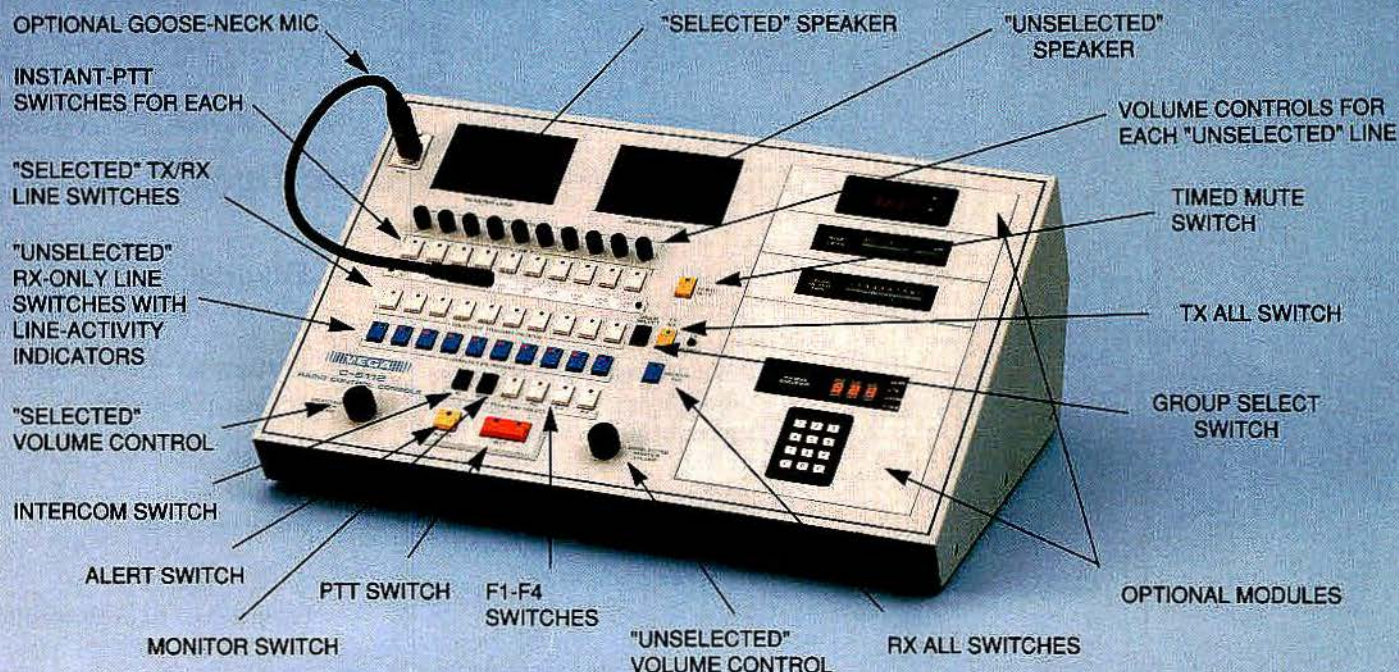
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On the cover: A medium-intensity strobe light marks a radio tower as an aviation hazard. See Lew Wetzel's article on page 10.

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UHF-TV channels 14 and 69 vs. private land mobile radio



The FCC has reached a decision in MM Docket No. 87-465 that it hopes will resolve interference between TV stations operating on UHF channels 14 and 69 and land mobile radio base stations operating on adjacent channels.

Here's the problem:

Land mobile radio station operators get the widest coverage when their base antennas are on towers, tall buildings and ridges. TV station operators like to put their transmitter antennas in some of the same places for the same reason.

When a TV transmitter is installed close to a land mobile receiver on a nearby frequency, some of the TV signal may spill over onto the land mobile frequency and interfere with reception.

To begin with, TV transmitters are not supposed to emit any radio energy on frequencies outside their assigned channels. But they do. It is a matter of degree, and FCC regulations specify the degree to which TV transmitters must suppress this out-of-band energy.

In most cases, UHF-TV transmitters that meet the FCC limit do not interfere with land mobile base station receivers because:

(a) they are on channels well inside the TV band, and signals that spill over the channel boundaries fall into adjacent TV channels left vacant for interference reasons.

(b) the transmitters are at locations controlled by the broadcasters, and the broadcasters do not allow susceptible land mobile base station receivers to be put too close.

Interference can result when a UHF-

TV channel 14 transmitter is installed at a location used by land mobile base station receivers in the 450MHz-to-470MHz land mobile band. The lower edge of channel 14 is 470MHz.

Similar interference can result when a UHF-TV channel 69 transmitter is installed at a location used by specialized mobile radio (SMR) base station receivers in the 806MHz-to-821MHz band. The upper edge of channel 69 is 806MHz.

Out-of-band radio energy

If a TV transmitter meets its specifications and, despite that, out-of-band radio energy still interferes with reception outside its authorized channel, the licensee must take steps to eliminate the interference. Possible steps include relocating the transmitter, changing the antenna, reducing the transmitter power and installing a filter.

Installing a filter usually is the most practical choice.

(Some broadcasters have changed antennas. They hate to reduce power because it may affect coverage, station value and advertising rates. And if there were a better location for the transmitter, it probably would have been put there in the first place.)

Unfortunately, remedies that a broadcaster may think are sufficient still may allow interference as far as the land mobile licensee with the receiver is concerned.

A series of complaints to the FCC and inspections by commission field engineers is likely to follow.

Motorola petition

"There are no total winners in these situations," reads a document on the subject submitted to the FCC by Stuart E. Overby, who is the manager of technical programs in the Regulatory Affairs Department in Motorola's Washington, DC, office.

"Without the proper degree of protection, land mobile users must contend with objectionable interference that seriously disrupts services critical to the public's safety and/or the efficient operation of businesses on which the public depends," the document continues. "To provide this protection, television

permittees bear some additional expense and, in some cases, may experience a lesser degree of flexibility in choosing a transmitter site," the document continues.

"In fact, eliminating the interference altogether to provide land mobile users the same quality of service currently attained would require that channel 14 or 69 UHF-TV operations not be authorized at all. Albeit a good technical solution for land mobile, Motorola understands this latter measure is unpalatable from an overall policy perspective."

Defining interference

What the FCC decided to do was to define how much interference a land mobile receiver can tolerate. (The definition is 17dBu as measured in a specific way.)

This level of interference is much higher than the level the FCC already decided SMR operators could tolerate from short-spaced base stations.

Whatever the reason for the difference, Motorola's document, a petition for partial reconsideration of the new FCC rule, points that it is not at all apparent why land mobile licensees should have to suffer more interference from channel 14 and 69 TV signals than that routinely allowed from other co-channel short-spaced land mobile systems.

To match the definitions of tolerable TV transmitter interference and tolerable short-spaced land mobile system interference, the limit should be changed from 17dBu to 11dBu, the Motorola document reads.

That means the out-of-band TV signal would have to be weaker, thus causing less interference to the land mobile receiver. The land mobile receiver would work better, but not as well as it would be expected to work if the TV transmitter caused no interference at all.

Land mobile radio licensees did not get as much relief as they should have when the FCC set the 17dBu interference limit. We support Motorola's petition to revise the limit to 11dBu, and the FCC should make that change.

—Don Bishop

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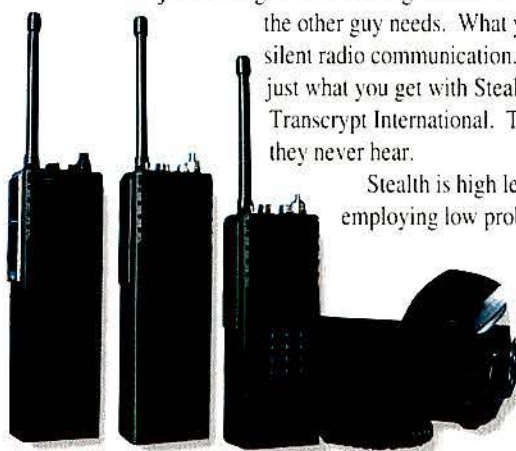
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Cellular passive repeaters:

I know this seems like the subject that will not die, but since reading numerous responses to the article written about passive repeater antennas ("Vehicular Cellular Passive Repeaters" by Dale Horn, July 1991) and particularly Raymond Trott's letter to the editor (January 1992), I am compelled to offer my 2 cents worth.

In my career as a cellular product engineer in both subscriber equipment and land-based systems, I have tested virtually every available passive repeater for the cellular market. The scope of my tests ranged from simply letting uninformed end-users try out the equipment to detailed, closely measured tests in an RF-controlled laboratory environment.

I have reviewed all the calculations presented, and I have made a few of my own. Although a formula on paper is a great foundation for design theory and predictions, it is no match for on-the-air testing.

The point brought out by the respondents to the article is that for each formula that "proves" the repeater offers a performance increase, there is another with the opposite result.

I found virtually no difference in field test performance among the various available repeater models. In my laboratory tests, I measured the RF output of a hand-held telephone transmitting in a screen box about 4 feet by 4 feet in size. The screen box was inside a large screen room with a spectrum analyzer and a cellular service monitor equipped with Advanced Mobile Phone Service (AMPS) protocol software.

Passing neatly (to ensure no RF leakage) through the screen box mesh wiring was the RF cable for an over-the-window repeater. Using the service monitor, calls were placed successfully to and from the phone inside the screen box with the box door open.

The phone's RF carrier was turned on manually at 28dBm.

These actions were accomplished with and without the repeater's radiating element installed.

RF levels were measured. With the box door closed, no calls were completed, again with and without the radiating element installed. The measured RF power from the repeater (door closed) was barely measurable on the spectrum analyzer.

This seems to indicate that the repeater is nothing more than a placebo, as many of your readers indicate. Regardless of the calculated and measured test results, a majority of those who use a repeater claim an increased call completion rate in previously unusable service areas, as well as heightened transmit and receive voice quality.

In my business, as in most others, the true bottom line is measured by customer response, not by a spectrum analyzer or scientific calculator.

If users are reporting favorable results, then how can I or anyone else

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Letters to the editor

question the motives, integrity or technical expertise of the likes of Dave Barquist ("Letters To The Editor," October 1991)?

Scott Wilson
Manager, Cellular Technical Support
Murata Business Systems
Plano, TX

Cellular privacy:

The cellular telephone industry is attempting to include a clause in the FCC congressional authorization bill to prohibit the manufacture of receivers capable of receiving cellular telephone calls.

TV sets can receive cellular telephone calls. Since the beginnings of radio communications, all parties who are cognizant of radio technology also are

aware that radio transmissions are subject to interception by anyone with a receiver. Throughout history, those who have expected their radio communications to be private have coded their messages. The secure telephone system used by the president on *Air Force One* and on the FBI's two-way radio system are examples of secure systems. It is, nevertheless, entirely legal to purchase a receiver to monitor these government signals, however unintelligible the reception may be. *The burden of making a radio emission private always has rested with the emitter of the radio signal.*

Now, the cellular industry is proposing that cellular equipment's lack of security feature be remedied by prohibiting the public from purchasing receivers that are capable of receiving cellular frequency bands. It is poor policy to establish a new legislative precedent restricting receiver design for a special interest group. This is outrageous. Next, the broadcast lobby will be badgering Congress to outlaw receivers that can be tuned outside the broadcast band.

The cellular industry is in a transition from analog to digital signals. There is no more ideal time than the present for the industry to adopt an encryption standard for this new transmission format. The public should not be restricted from buying receivers of any certain design because the cellular industry did not make an attempt to create an industrywide encryption standard.

Jon Cereghino
Mountain View, CA

Fast Fact Card comments:

It would be nice to have an article on a "cellular city," such as Pittsburgh. We have overcome many terrestrial obstacles in the last few years.

Donald W. Miller
Pittsburgh Cellular
Pittsburgh

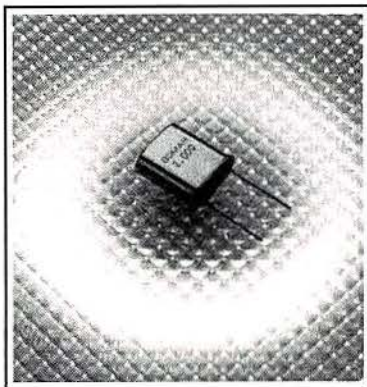
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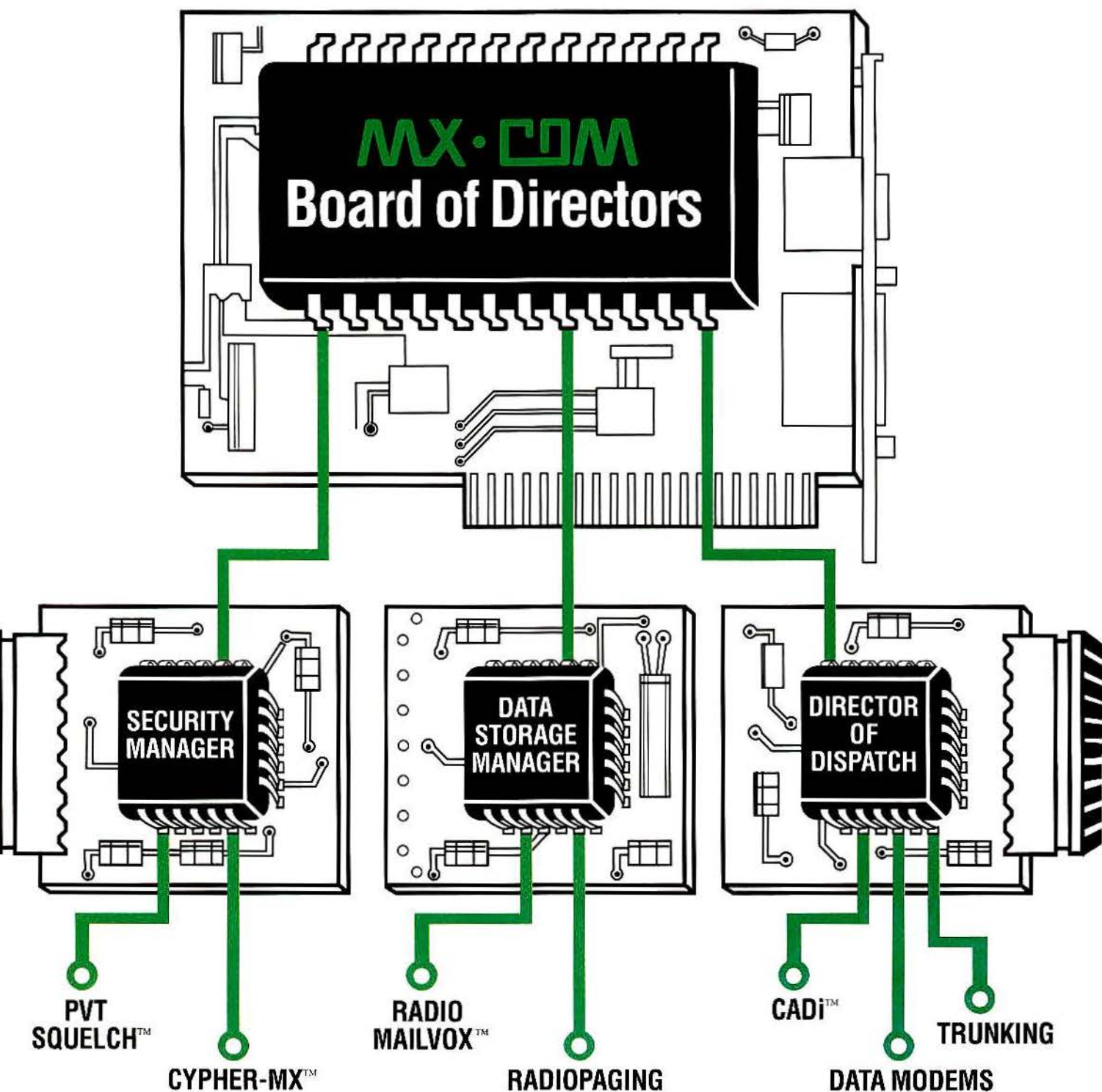
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Using white lights to mark radio towers

Parabolic reflectors on white strobe lights reduce ground scatter light. As a result, more tower owners and operators can take advantage of white strobes to reduce tower operating and maintenance costs.

By Lew Wetzel

When selecting aviation warning beacons to comply with Federal Aviation Administration (FAA) regulations, owners and operators of communications and broadcast towers typically opt for the slow-burning, red incandescent type rather than quick-flashing white strobes.

It is a comfortable choice. Red beacons have been around for so long that they became an accepted quantity. Placing white strobes on a new tower—or converting from red beacons and side-lights to white beacons on existing towers—is risky business, many believe.

Now, because of a new design for white strobes and other advances, tower owners, operators and licensees have more reason than ever to use white strobe beacons either alone or in combination with red beacons.

Scatter light

Tower owners and operators have shied away from white strobe beacons because they perceive them as more difficult and costly to install and more noticeable than red beacons to viewers at ground level.

Actually, white strobe beacons are easier to install. For towers of moderate height, only a top white strobe beacon is required. For the same tower to meet requirements with red lights, a red top beacon and three side lights and cabling may be necessary. Moreover, the white strobe light's electronics are easy to adjust.

The real drawback of white strobe beacons is the dispersion of light

through their Fresnel lenses. These large, ribbed acrylic lenses are used by almost all white strobes to focus light energy into a relatively narrow beam.

Conceived in 1821, Fresnel lenses came into widespread use in lighthouses around the turn of the century. (See photo below.) But the Fresnel lens was designed for point sources of light, not the light radiated from a large helical flashlamp.

The traditional Fresnel lens-helical flashlamp configuration does not provide an optimum vertical and horizontal light beam pattern, causing some light energy to be dispersed outside the

intended beamwidth. (See Figure 1 on page 12.)

Although the attention-getting flash from a white strobe beacon is highly effective in warning pilots of an obstruction in their flight paths, the light scattered by a strobe's Fresnel lens makes it noticeable on the ground.

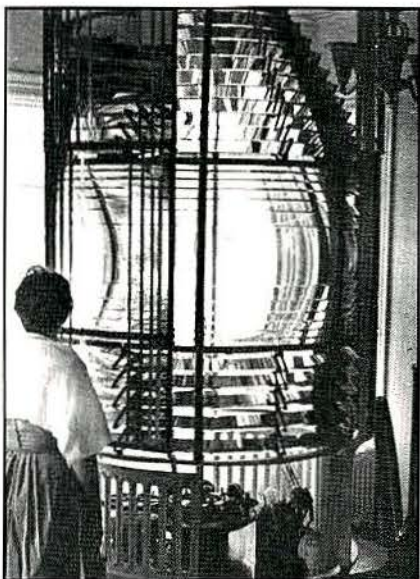
Red incandescent beacons use Fresnel lenses, but their scatter light is not a problem. Although they consume as much as 25 times more power than white strobes during night operation, the two incandescent bulbs in a red system operating at a combined 1,240W produce a much softer color—so soft, in fact, that red beacons are not effective in marking towers during the day.

Because of the scatter light from a white strobe equipped with a Fresnel lens, the less conspicuous red beacon often has been the only acceptable option for towers in densely populated areas and certain other situations.

New strobe design

A new design for white strobe beacons largely has solved the problem of ground scatter light. The new strobe system can be employed in situations where only red beacons were viable before.

Instead of using a large, bulb-like helical flashlamp and Fresnel lens, the new beacon design employs three linear quartz flashlamps, each with its own parabolic mirror. The parabolic mirrors concentrate the light output and focus it into a narrow beam that effectively



This example of a Fresnel lens was installed in the Petit Manan lighthouse in Maine in 1855. It was manufactured by Henri LePaute of Paris. Photo courtesy of the Shore Village Museum, Rockland, ME.

Wetzel is senior sales engineer with EG&G Electro-Optics, Salem, MA. He has worked in broadcasting and related fields since 1952.

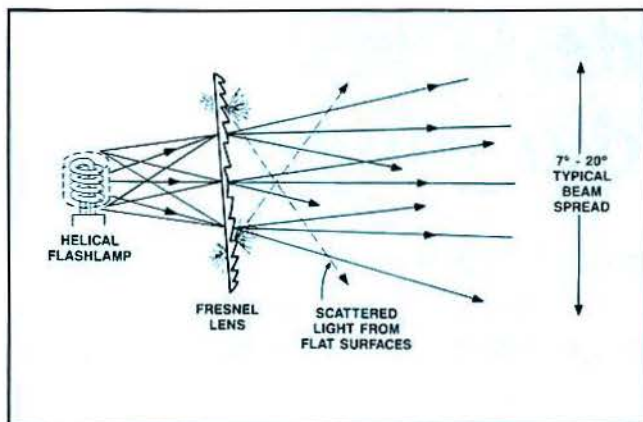


Figure 1. The traditional Fresnel lens-helical flashlamp configuration does not provide an optimum vertical and horizontal light beam pattern, causing some light energy to be dispersed outside the intended beamwidth.

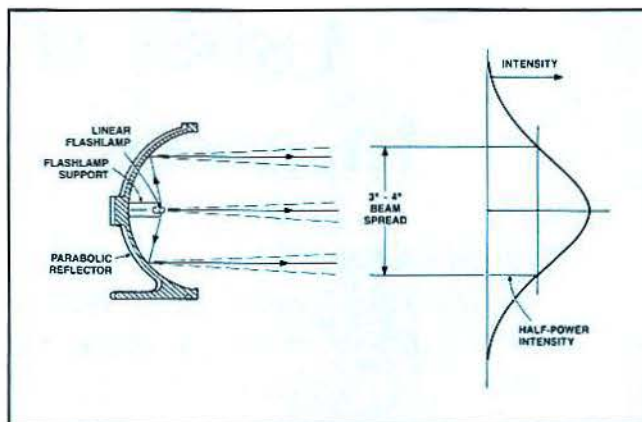


Figure 2. The new beacon design employs three linear quartz flashlamps, each with its own parabolic mirror. The parabolic mirrors concentrate the light output and focus it into a narrow beam that effectively eliminates scatter light.

eliminates scatter light. (See Figure 2 above.)

The new reflector-type beacons pack more than 20,000 candelas of light intensity into a vertical beam of only 3° to 4°, about 50% narrower than Fresnel-lensed beacons. (See Figure 3 on page

14.)

Because light from a white strobe can be seen much more easily at night, the light intensity is switched automatically to 2,000 candelas at night.

The new beacon design provides a long list of advantages, including lower

maintenance, lower energy consumption and less tower stress from wind-loading.

Because the light output of the new flashlamps is intensified, they consume only 160W for daytime use and 30W at night. This compares with 180W and

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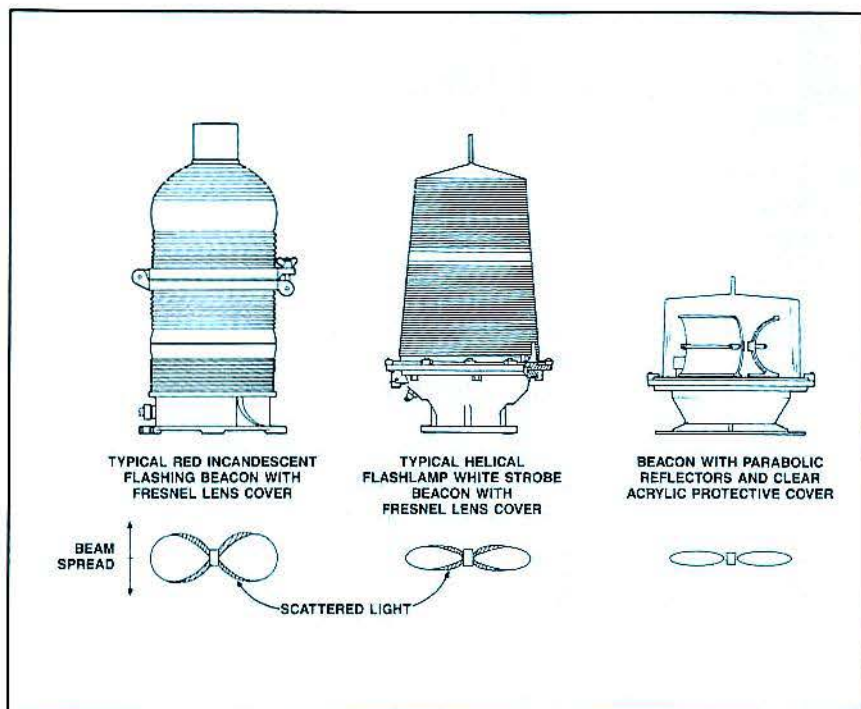


Figure 3. The new reflector-type beacons pack more than 20,000 candelas of light intensity into a vertical beam of only 3° to 4°, about 50% narrower than Fresnel-lensed beacons.

50W for helical flashlamps and 1,500W for a red incandescent beacon and three steady-burning sidelights.

In the new parabolic beacon, the reflector assemblies are laid flat in a triangular formation to provide full 360° coverage. Each reflector can be tilted up by the manufacturer to adjust the beam above the horizon to compensate for different terrains or obstacles and still comply with FAA specifications.

Because Fresnel lenses used in traditional white strobe beacons cannot focus light output too tightly, they produce an unnecessary amount of scatter light and require more electricity than parabolic flashlamps.

Moreover, the light output from helical flashlamp-type white strobe beacons degrades significantly over the flashlamps' operating life. Danish Telecom has documented that, over a three-year period, its helical flashlamps with Fresnel lenses degraded to 40% of their original light output.

In addition to the gradual degradation of flashlamp efficiency, the lens' interi-

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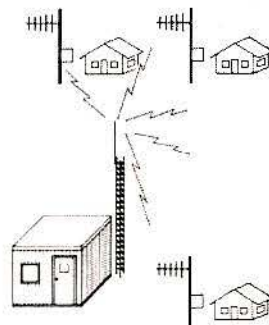
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or surface is oxidized by ultraviolet (UV) light and ozone. This gradual fogging, which resembles frosted glass, is caused by corona and UV light produced by the trigger wire on the helical flashtube, which is pulsed 40 times per minute.

The new parabolic reflector flashlamps are linear in shape and about 5 inches long. Fabricated of special quartz, the flashlamps do not produce ozone or UV light and are series-triggered, thereby eliminating the corrosion and lens degradation associated with other beacon systems.

Advanced acrylic materials used in the clear optical cover (no lens is needed) effectively withstand heat from the flashing lamps and cold from high, exposed locations. The materials remain stable to a temperature as high as 60°C, higher than any Fresnel-type lens in use today, and they are unaffected by UV light. As a result, the acrylic globe remains clear.

Although using red incandescent bea-



A quality-control technician at EG&G Electro-Optics inspects a linear xenon flashtube before it is installed in a parabolic reflector beacon.

cons avoids complaints about scatter light, their maintenance can be a problem. Red beacons require lamp replace-

ment at 75% of the rated life of the lamps to comply with FAA and FCC requirements. This means lamps may have

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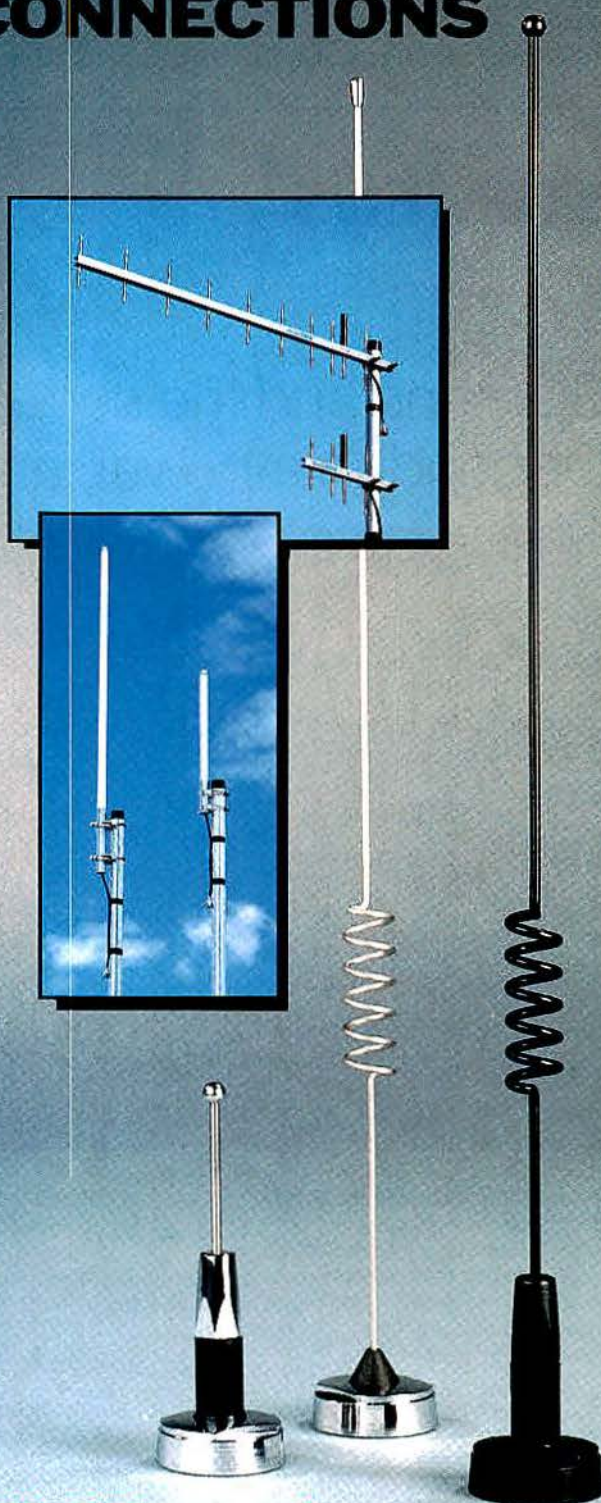
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to be replaced as often as twice a year.

Tower owners, operators and licensees can be held liable in the event of an aviation accident if proper beacon maintenance has not been carried out. Non-compliance with FCC rules may result in substantial fines.

Obviously, all types of warning beacons require periodic lamp replacement to keep light intensity within FAA and

FCC specifications. Red incandescent lamps normally are replaced every six to nine months; white-strobe flashlamps normally are relamped every two years. The new parabolic-reflector flashlamps can operate within specifications as long as three years without replacement.

Longer lamp life means fewer trips to the top of the tower. A single trip can cost anywhere from \$300 to \$1,000 for

labor alone, depending on the tower location and height. Replacing a Fresnel lens on a red or white beacon may cost \$500 to \$900, not including lamp replacement.

With only 1.3 square feet of surface because of its low-profile acrylic cover, the parabolic system is less vulnerable than other beacons to corrosive UV light, vandals' bullets and high winds. The windload is 72 pounds at 150 mph.

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Replacing red lamps

If you already are using incandescent red lamps, you may want to—or have to—keep using them. Red beacons may be the only option for marking towers in densely populated areas and certain other situations, such as near airports or in tower clusters where the FAA requires uniformity with other red beacons already in operation.

If a red beacon and sidelights are in use for night marking, the FAA requires the tower to be painted in bands of international orange and white paint. Paint deteriorates at different rates depending on location and weather, but most towers must be repainted every few years to maintain the paint's color and coverage. Modern towers made with hot-dipped galvanizing do not hold paint well. No-lead paints that meet environmental requirements do not hold up as well in various weather conditions as previous mixtures did.

Fortunately, in many situations the FAA approves the substitution of a white strobe beacon for daytime use in place of paint. The typical cost of a beacon, \$2,300 to \$2,500, can be roughly equivalent to the cost of painting the tower once. Thereafter, every painting omitted is money saved.

Highlighting the options

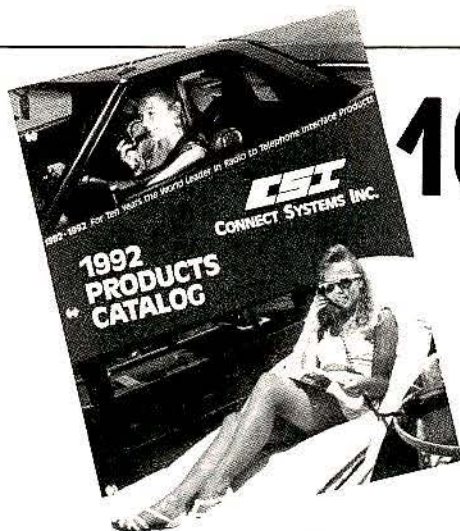
Would you be better off with a white strobe beacon?

If scatter light is the main objection to using white beacons, the parabolic reflector design may be the solution.

If maintaining paint and red lamps is too expensive, a white strobe can help to reduce repairs, lamp replacement, energy costs and painting.

The options are not mutually exclusive. You may have more options than you think.





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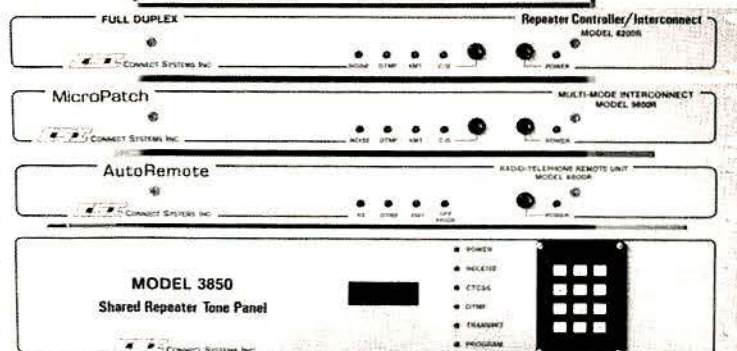
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Tower lighting: Complying with FAA, FCC regulations

Radio licensees cannot necessarily rely on tower owners to observe and document tower light operation and to report and repair malfunctions. Federal regulations make licensees responsible for compliance.

By Nicki Mezger, Dave Dauffenbach and Phil Voegeli

Compliance with FCC radio tower lighting requirements is an issue facing many radio licensees and tower owners.

Continuous observation of lighting equipment operation reduces the risk of aircraft colliding with towers and the risk of monetary forfeitures imposed by the FCC for non-compliance.

Mezger is president, and Dauffenbach and Voegeli are design engineers at ICT Systems, Wichita, KS. The company offers tower lighting products and malfunction reporting services described in this article.

Aviation safety, administered by the Federal Aviation Administration (FAA), is paramount. Almost without exception, when the FAA wants lights on a radio tower, the FCC specifies lighting in every radio license issued for the tower. FAA evaluation factors include tower height, surrounding terrain, adjacent structures, population density and air traffic patterns.

The FCC inspects radio towers and enforces aviation obstruction marking regulations against radio licensees. Pending legislation would place all radio tower owners under FCC jurisdiction, not just owners of abandoned radio towers as presently is the case.

Instituting continuous observation for existing towers may require upgrading both equipment and observation methods.

Radio licensees on proposed new towers have the opportunity to select or influence the selection of lighting equipment, as well as observation, documentation and reporting methods intended to ensure continuing compliance.

FAA and FCC regulations are inconsistent, so radio licensees should be familiar with both. (See box below.) The intent and interpretation of the regulations make a difference in the equipment used to control and monitor tower facilities.

Tower illumination: FAA and FCC regulations

FAA

Any failure or malfunction that lasts more than 30 minutes and affects a top light or flashing obstruction light regardless of its position should be reported immediately to the nearest automated flight service station (AFSS) or flight service station (FSS) so a Notice to Airmen (NOTAM) can be issued. (FAA Advisory Circular AC70/7460-1H, Chapter Two, Paragraph 23)

Note: The FAA statement is more stringent in that it allows only 30 minutes from time of failure for the problem to be reported.

FCC

The licensee — (a) Shall report immediately...any observed or otherwise known extinguishment or improper functioning of any top steady burning light or any flashing obstruction light, regardless of its position on the antenna structure, not corrected within 30 minutes. (FCC Regulations, 47 CFR 17.48 in part)

The FCC ruling reads that notification must be given within 30 minutes of observation of a flashing beacon outage if not corrected within that time.

Observation is the key and, when taken in conjunction with 47 CFR 17.47, the interpretation is more lenient than the FAA ruling. Part 17.47 reads that there is to be a visual observation of lighting or observation of an automatic indicator each 24 hours. Although it reads that, alternatively, the licensee can install an automatic alarm system, the statement requires notification within 30 minutes of the time the outage is observed.



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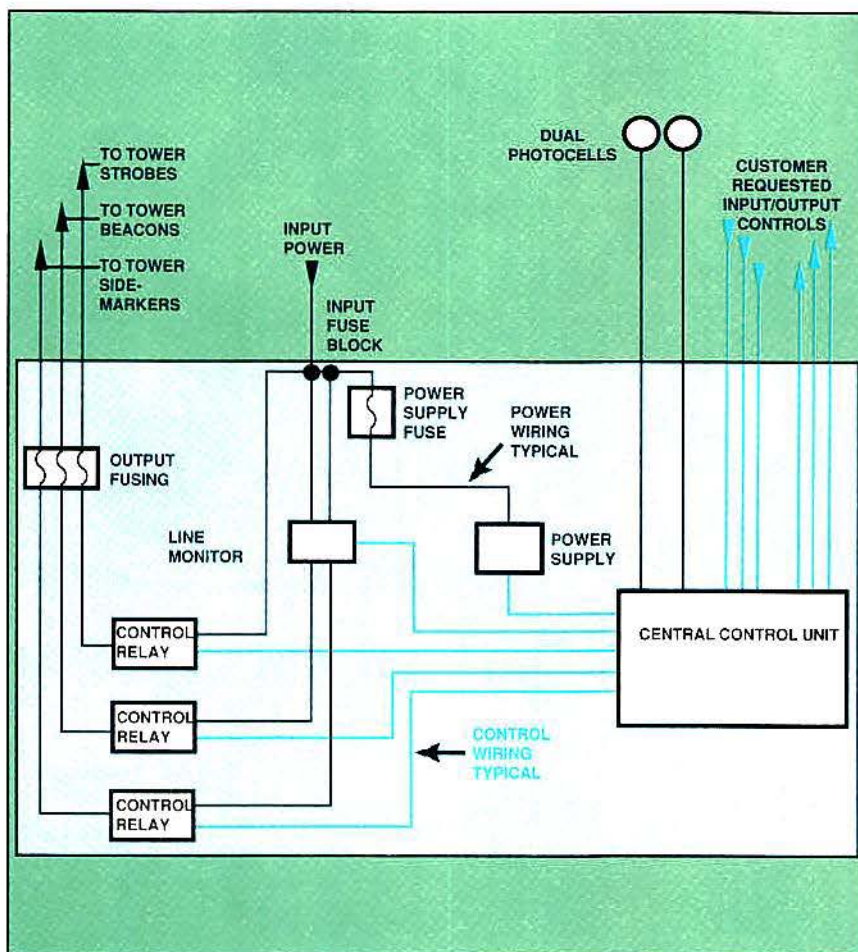


Figure 1. An operational block diagram for a tower lighting and environmental control system. The central control unit processes data from sensors, controls lighting and other tower facilities, and communicates with the central monitoring facility.

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Devices to control when the tower is illuminated and how flashing beacons operate have been manufactured for many years. Although not all such devices comply with regulations, how they should work is relatively clearly defined, and it is easy to obtain proper operating hardware.

Requirements for documenting and reporting lighting equipment malfunctions often are misinterpreted, misunderstood and, to some extent, disregarded. Three methods are in common use:

► *Visual observation*—Someone near the tower observes it daily and logs the date and time of observation. The observer usually is instructed to report immediately any problem observed. The log documents observation and malfunction reports.

► *Passive alarm*—To observe tower lighting passively, a closed-contact alarm is connected to the illumination control and linked to a radio licensee's transmitter equipment.

Lamp outage signals are sent through the radio licensee's remote control system to a central monitoring facility. The alarm may indicate a lighting system malfunction, or it may tell specifically which beacon or sidemarker light is out.

► *Active alarm*—Active tower lighting observation may use a modular, stand-alone controller. The controller monitors and logs tower operating characteristics continuously. When a malfunction triggers an alarm, telemetry carries the indication to someone designated to handle lighting matters.

Intelligent alarms

Flexible site control and data collection systems apply control and monitoring methods to collect data about actual operating conditions at tower facilities 24 hours a day. Reports generated from the data can provide:

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□ recommended lamp replacement time.

The same monitoring capabilities can improve control of heating, ventilation and air conditioning (HVAC); site intrusion; perimeter lighting; and security access.

Figure 1 on page 22 is an operational block diagram for a tower lighting and environmental control system. The

lighting control is preselected from standard tower configurations with operating limits set according to FAA and FCC requirements. Lighting control differs from site to site and can be modified readily to meet special needs.

The customer supplies utility power to the tower control unit's power input. Via internal wiring, the system distributes power to the main processor pow-

er supply, including its battery backup.

Analog conversion blocks (ACBs) in the central control unit operate the control relays. The ACBs analyze data received from dual photocells, lighting monitors and other sensors to control output contactors on the relays that switch power to the tower beacons, side-markers and other control points the customer designates.

Power outputs to the tower lights are fused, as is the central control unit input.

An on-line uninterruptible power supply (UPS) powers the central control unit to ensure that utility power fluctuations do not hinder data accumulation and processing.

Remote communications with the central control unit can be conducted with any RS-232 communications device. Telephone lines, radio frequencies and microwave links can be used to communicate with the central control unit according to site requirements and customer preferences.

Sensors are monitored constantly, and their indications are compared to nominal site operating characteristics. When there is a difference, the central control unit calls the central monitoring facility and transmits the information to an operator on duty.

The central control facility is attended 24 hours a day. A control facility operator telephones the FAA to report light outages and restorations of lights.

These "live telephone calls" are the best way of complying with reporting requirements because notification by this method always satisfies the FAA. Other methods, such as automatic data transfer, facsimile messages and automatic telephone dialers that play recorded messages may be rejected by the FAA as satisfactory reporting because such notifications may not reach the right FAA flight service station employee within 30 minutes of an outage observation.

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Steps to follow to procure a tower

Plan not only for present requirements but for future changes and additions to ensure your tower will meet your needs during its useful life. Various manufacturers offer a wide selection of choices.

By Kurt Penfold, P.Eng.

Tower procurement usually starts with a need, as defined by an assortment of antennas and transmission lines to be placed at various heights at a given location.

Possible future antennas and transmission line requirements should be considered, too. The planning stage is the best time to consider potential changes, additions or both to future antenna loading. The cost of procuring additional tower strength at the outset is small, compared to the cost to reinforcing an existing tower and foundation. Major, unplanned changes in antenna loads made after tower installation usually require such reinforcement. Sometimes, the tower may have to be replaced with a larger one.

Procurement approaches

- *Single source*—One way to procure a tower is to retain a tower company's services and their engineers' advice to design an economical tower that includes extra capacity for certain future attachments. Few tower buyers use this approach because, although it yields a suitable tower, it does so without competition from multiple tower designers and suppliers.

- *Specification and bid*—Another way is to write a specification yourself or together with a consultant and to solicit bids from several tower companies. The specification should request sketches or drawings of the proposed tower and

Penfold is engineering manager at Trylon Manufacturing, Elmira, Ontario.



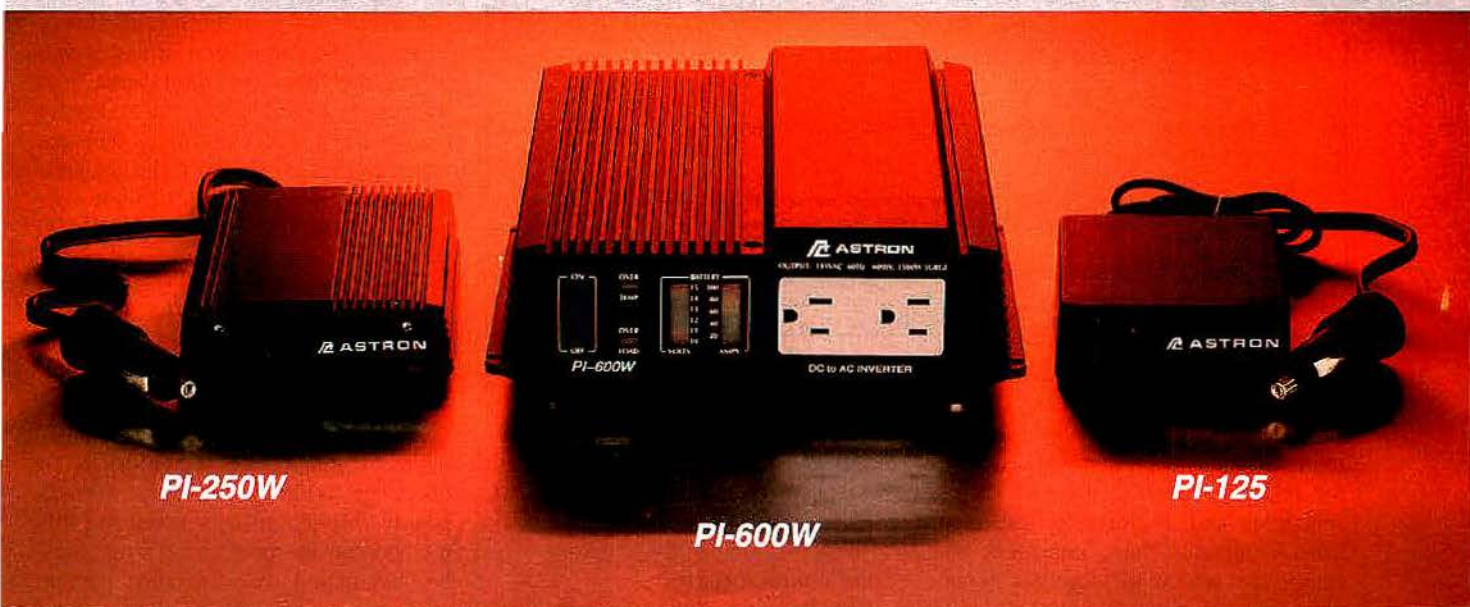
Design, supply and installation of a self-supporting tower cost two times or more what they do for a guyed tower, depending on height.

foundations. Towers from different vendors can differ in size and, therefore, price. *Caveat emptor.* (Let the buyer beware.)

To win a competitive bid by offering the lowest price, the designer tends to make the tower as small as possible, given the antenna and transmission line

loading; building code requirements; deflection; and conditions set by the buyer. Tower buyers who use competitive bidding should work closely with radio design and network system planning groups to ensure their specifications meet structural capacity and stability requirements for the initial and

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Tower procurement approaches

- ☐ **Single source**—Use a tower company's services and their engineers' advice to design a tower.
- ☐ **Specification and bid**—Write a specification yourself or together with a consultant and solicit bids from several tower companies.
- ☐ **Consultants**—Hire a consultant to design, analyze and inspect.

future antennas, transmission lines and other attachments.

Reputable tower designing and manufacturing companies are sources for reliable information about prices, schedules and engineering guidance. Such companies have engineers and technicians who work closely with purchasing, manufacturing and erection teams.

- **Consultants**—Consultants who specialize in towers are a source of unbiased, objective information for writing tower design specifications. They

offer professional services, including design, analysis and inspection. They can check designs produced by others to ensure specification conformance if there is any doubt about a proposed or installed tower.

Load characteristics

For the most part, an attachment's size and shape affect tower loading more than its weight. An antenna's weight seldom has much to do with calculating the tower size.

For example, on a 90m-high guyed or

self-supporting tower, if all the antennas and transmission lines weighed only 1 pound, the calculation of forces that affect the tower's components and deflection would differ only slightly compared to a calculation that includes true weight. Conversely, if the antennas and transmission lines on the same tower are considered as weighing 2,000 pounds and as occupying no space, the tower analysis would reveal much lower forces affecting the tower components and a markedly different deflected shape than an analysis that includes the true space the load occupies.

Economy can be achieved by attaching transmission lines to or close to the tower legs to limit wind and ice load exposure. Money initially saved via this method may be spent later if a line must be "unbundled" because labor must be paid.

Angle adapters are an alternative, but they can add a substantial, unnecessary cost.

Where it is practical, the preferred alternative is to use transmission line



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Standards tower purchasers may specify

- ❑ Canadian Standard S37, "Antennas, Towers and Antenna-Supporting Structures—A National Standard of Canada."
- ❑ RS-222D, "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures—An American National Standard."

Note: Some manufacturers produce towers designed to criteria other than the national standards.

brackets. These galvanized steel brackets have holes to attach standard stainless-steel hangers at 30-inch-to-60-inch intervals on the tower mast. They eliminate the need for nylon ties, angle adapters and stainless-steel wraplocks and allow the transmission line to be attached neatly with standard, serviceable hanger kits.

Tower strength

• *National standards*—Minimum recommended tower strength requirements are published in structural standards or

are specified by the purchaser.

In Canada, with one exception, tower strength and design are not regulated. Therefore, Canadian Standard S37, "Antennas, Towers and Antenna-Supporting Structures—A National Standard of Canada," is not a legal requirement.

In the United States, the tower design and construction standard is RS-222D, "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures—An American National Standard."

Usually, these standards are specified by purchasers as the minimum acceptable levels of strength, material and erection requirements.

These standards undergo constant review by committee. They are revised and reissued from time to time to reflect current knowledge of loading, analysis technique, materials and workmanship. Their content is consistent with other national standards that are referenced throughout the tower standard documents.

A major difference between the American and Canadian standard is that the Canadian standard specifies mandatory ice and wind loads. The American standard does not require ice loading.

• *Manufacturer standards*—Some manufacturers produce a commercial, over-the-counter type of tower that is designed to criteria other than the national standards.

Such a tower represents a low-cost product for a specific and usually limited application. Failure incidents tend to be more frequent with structures that do

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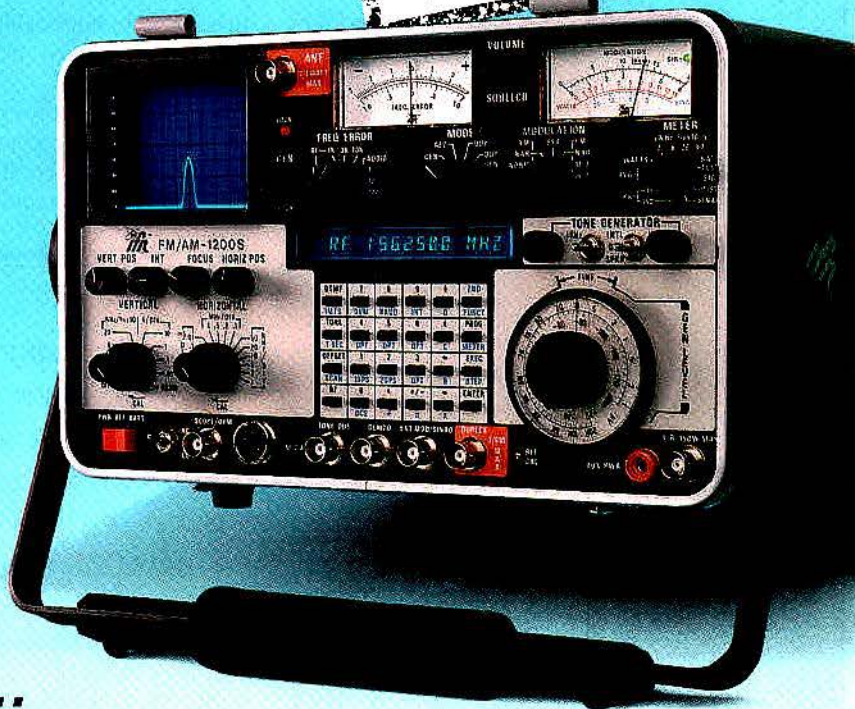
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Tower materials

- ❑ **Angle**—Steel angle offers strength, stability and low maintenance, but it may be more expensive.
- ❑ **Round**—Pipe, tube and solid steel have a high compressive capacity-to-weight ratio, but hollow sections may corrode and crack.

not conform to either the Canadian Standards Association (CSA) or American National Standards Institute (ANSI) standards. The best advice is to consider the risk and consequences of tower failure before using this kind of product. For example, these towers usually are designed to survive a specific and uniform wind velocity with no ice loading. They have little or no safety factor beyond the wind loading.

Tower types

Types of towers can be classified into two general categories, guyed and self-supporting. Each type has different capacity, stability and versatility limitations.

The design, supply and installation cost of a self-supporting tower is approximately twice that of an equivalent guyed tower at heights ranging from 16m to 76m. For towers higher than 76m, the cost difference is much greater.

Guy stays stretch with time. Guy assembly tension should be adjusted a year after installation and checked every five years thereafter. The scope of recommended tower inspection and maintenance is published by CSA and ANSI.

Materials

Steel—galvanized after fabrication—is used for most tower mast construction. Galvanized guy or bridge strand is used for most guy stays that support guyed towers. Tower lattice mast is made with a variety of steel shapes and connection types.

- **Angle**—A common mast makeup for a tower supporting multiple microwave dishes and transmission lines includes angle legs, angle bracing and bolted construction with a climbing ladder inside the mast. This configuration offers relatively low manufacturing cost,

high strength, high stability, easy antenna attachment, easy maintenance and low shipping cost.

But this type of tower has a relatively high, flat (angle) projected area, making it more expensive than a comparable tower made of round members, such

There are many pros and cons to tower design, including material selection, welded or bolted connections and mast configurations.

as pipe, tube and solid round. The price difference decreases as the antenna and transmission line load increases.

- **Tube**—The most economical steel sections for tower mast components are hollow tubes and pipes with circular cross-sections. These sections offer the highest compressive capacity-to-weight ratio and lower wind resistance. Canadian designers and manufacturers have, for the most part, excluded the use of thin-wall, small-diameter, hollow sec-

tions for primary structural components (legs) in tower construction for several reasons. Even properly vented sections entrap debris and water, which later freezes, in time.

Entrapped, freezing water expands, exerting pressure on the tube. The water may carry debris that can block the tube's drain holes. When drain holes are blocked, moisture and any chemicals in it may be trapped inside the tube for an extended period. The tube's galvanized inner surface can be subjected to corrosive action, depending on the acidity of the water, debris and chemical mixture within the tube. Moreover, the inner galvanizing may not be thorough. It is impossible to inspect the entire inside surface of a long, slender section.

Inspecting a tower that has been subjected to corrosive influences and expanding ice pressures may not reveal structural distress until a crack or hole appears in the tube wall. Once the deterioration becomes that serious, the tower may have to be dismantled. Such deterioration has led to the dismantlement of several guyed towers in Canada.

Pros and cons

There are many pros and cons to tower design, including material selection, welded or bolted connections and mast configurations that include transmission line bracket and ladder positioning and facilities for attaching antenna mounts. Even based on the same specification, bids for tower accessories such as grounding, climbing safety devices, anti-climbing devices and waveguide bridges may carry different prices.

A thorough evaluation of a tower proposal and the tower company's expertise and reputation, together with the price, should be carried out in the process of selecting a tower structure.



Types of towers

- ❑ **Self-supporting**—Design, supply and installation of a self-supporting tower cost two times or more what they do for a guyed tower, depending on height.
- ❑ **Guyed**—Guy stays stretch with time. Tension should be adjusted one year after installation and checked every five years thereafter.

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Pre-distortion simplifies mobile data integration

Interfaces between data modems and existing voice-grade radios are more efficient with pre-distortion signal processing. Thus, a larger number of radio models can be used for 4,800bps and 9,600bps operations.

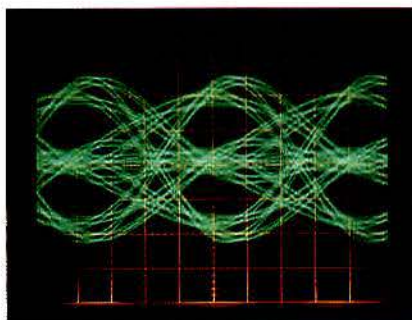


Photo 1. An eye pattern distorted by the Mitrek circuitry.

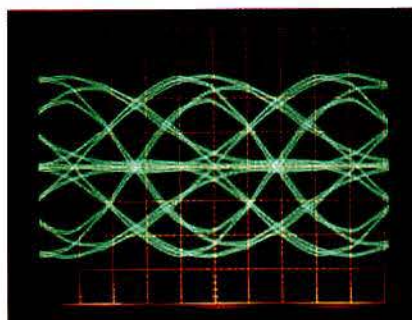


Photo 2. An eye pattern of a pre-distorted signal.

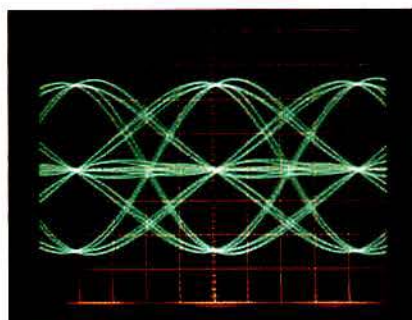


Photo 3. An eye pattern of a pre-distorted signal after it passes through the Mitrek circuitry. Note how the resulting signal is symmetrical and how it converges to three distinct points.

By Barry Dorr

Pre-distortion is a signal processing technique that yields more efficient interfaces between data modems and existing voice-grade radios.

A result of this technology is that a greater number of radio models can be used for 4,800bps and 9,600bps operation, and fewer radio modifications are required. Thus, users can send high-speed data while retaining their investment in mobile radio and base station equipment.

How pre-distortion works

As a general rule, higher data rates occupy more audio bandwidth than lower data rates, requiring radios with a wider audio bandwidth. Audio group delay must remain relatively flat over this bandwidth. At 4,800bps data rates, voice-grade radios normally do not meet the requirements for bandwidth and group delay.

System integrators traditionally solve this problem by modifying the radio so that the transmitted signal is sent directly to the voltage-controlled oscillator (VCO) input. When this method is not possible because of low impedance, low distortion or the lack of a good audio summing point, the radio model is rejected for use at high baud rates.

The solution is to select a convenient transmit interface point and digitally

pre-distort the signal in the modem.

As an example, the Motorola Mitrek radio's VCO input has a 100 Ω input impedance, which is too low for a low-power data modem. The radio has an interface point that has high impedance and that allows summing of the voice signal, but it does not provide a satisfactory interface at 4,800bps.

The audio magnitude and group delay of the transmit circuitry between the selected interface point and the VCO input are shown in Figure 1 on page 37. As with most radios, the Mitrek's high-

As a general rule, higher data rates occupy more audio bandwidth than lower data rates, requiring radios with a wider audio bandwidth.

frequency audio response is limited to reduce noise. Although it is not shown by the graph, the low end of the radio's audio frequency response is limited by capacitive coupling in the audio path.

The audio spectrum of the 4,800bps Nyquist-filtered bipolar (NFB) signal is shown in Figure 2 on page 37. Because the signal has no low-frequency component, the low-frequency limitation due to capacitive coupling is not a problem.

The high-frequency limitation, how-

Dorr is a senior engineer and group leader at Coded Communications, Carlsbad, CA. He has B.S.E.E. and M.S.E.E. degrees with an emphasis in communications and signal processing. The technology discussed in this article is incorporated in Coded's IQmodem product.

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Definitions:

Digital signal processing (DSP) — The processing of analog signal using digital techniques.

Eye pattern — The waveform pattern of a modulated digital signal as seen on an oscilloscope. The vertical display is driven by the information-carrying waveform, synchronized by the system clock.

Group delay — A type of distortion caused by different frequencies that take different amounts of time to pass through a filter.

Nyquist-filtered bipolar (NFB) — A signaling technique commonly used at 4,800bps. The most salient characteristic of this scheme is that it has no dc component. Therefore, an NFB signal passes through capacitively coupled channels.

Transfer function — A function that describes the magnitude and group delay response for a linear filter.

Voltage-controlled oscillator (VCO) — The fundamental element of an FM transmitter. The VCO converts audio-level signals into deviations of an RF carrier's frequency.

ever, causes distortion. Photo 1 on page 34 is an eye pattern distorted by the Mitrek circuitry. The distortion it represents is unacceptable.

The signal will be passed by the Mitrek if it is pre-distorted so that the transmit circuitry *actually is required*

...the transmit circuitry actually is required for a clean signal.

for a clean signal. This is done as follows:

If the transfer function of the transmit circuitry is $H_d(s)$ and the desired transfer function of the modem and processing circuitry is $H_n(s)$, then the digital filter required for the Mitrek can be expressed as $H_n(s)/H_d(s)$.

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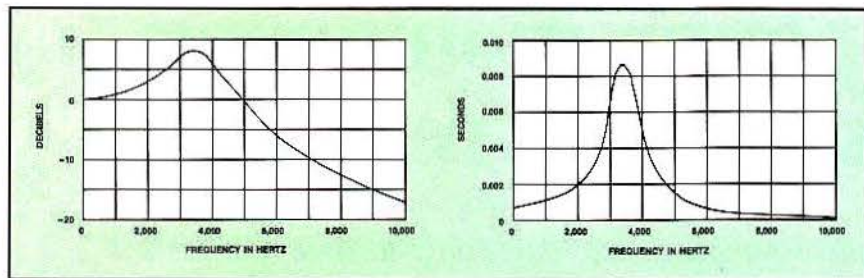


Figure 1. The audio magnitude and group delay of the transmit circuitry between the selected interface point and the VCO input.

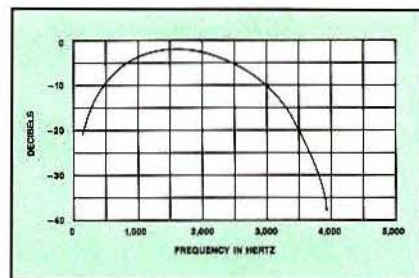


Figure 2. Audio spectrum of the 4,800bps Nyquist-filtered bipolar (NFB) signal.

With this filter, the cascaded response is $H_n(s) * H_d(s) / H_d(s) = H_n(s)$.

The pre-distorted eye pattern is shown in Photo 2 on page 34. When this signal is passed through the Mitrek transmit circuitry, the result is as shown in Photo 3 on page 34. Note how the resulting signal is symmetrical and how it converges to three distinct points.

Implementing pre-distortion

In the modem, digital transmit filters for many radio types are stored in memory. During initial setup, a filter is

In the modem, digital transmit filters for many radio types are stored in memory.

selected that is matched to a factory-recommended transmit interface point.

Pre-distortion is a signal processing technique that allows high-speed data to be sent using voice-grade radio equipment—one of many uses for digital signal processing in mobile radio communications.

Using digital signal processing to correct for the imperfections and differences in existing radio equipment allows users to send high-speed data and retain their investment in mobile radio and base station equipment.

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Remote power monitoring improves service response

Have you ever responded to a mountaintop site, only to find you needed something from the service shop to fix the problem? A remote power monitor system could help you to avoid such a situation.

By Andrew Singer

Most land mobile radio communications service companies have equipment at remote sites. The equipment may range from a remote base station to a trunked radio system. Each site may have many customers who depend on the equipment and need to know whether it functions correctly.

One way of finding out is to bring test equipment to the site.

Another way is to use a remote power monitoring system to monitor and test remote transmitters and antenna systems. One such system includes a remote network controller (RNC); at least one remote power monitor (RPM); and

RF power sensors. The user furnishes a dial-up telephone line; modems; a personal computer or terminal; an RS-232 cable; RG-58 coaxial cable; and two-conductor shielded cable.

As shown in Figure 1 below, the RPM communicates to the network controller via the local area network (LAN) data bus. The RPM visually monitors the site from a distance. It monitors as many as six RF channels for forward and reflected power, six voltages and temperature. It has six open collector outputs.

When connected to an RF power sensor, the RPM can monitor transmitter RF output and reflected power.

The RPM's six RF ports can be connected to a five-channel trunked system and combiner output or to six conventional repeaters. The alarm threshold can be set remotely for the lower limit on forward power and the upper limit on reflected power.

Six voltage sensor inputs are available. They can be connected to any volt-

age source, including power supply, batteries and solar panels. Upper and lower limits can be set for alarm purposes. These inputs have a range of 0Vdc to 20Vdc. Each input measures voltage independently.

In cases where the power source is outside the range of 0Vdc to 20Vdc, a resistive voltage divider, such as the examples shown in Figure 2 on page 40, can be used.

A built-in temperature sensor with a range of 0°F to 212°F is located in the RPM unit. An upper and lower alarm threshold can be set for this sensor. If the temperature exceeds the set limits, an alarm is generated. Alarms can be configured in various ways to alert operators, technicians and others.

The RPM's six uncommitted open collector outputs can control other site equipment. They can pull 300mA to ground. These six switches can operate such devices as antenna cut-over relays, spare transmitter power amplifier

Singer is product manager for Antennas Specialists, Solon, OH. When this article was written, he was senior applications engineer at Sinclair Radio Laboratories, Tonawanda, NY.

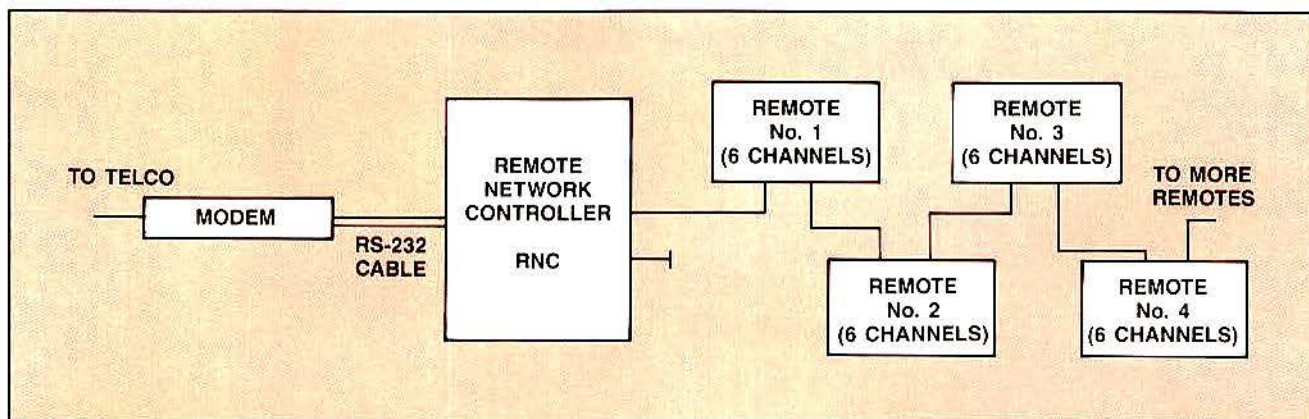


Figure 1. The remote power monitor communicates to the network controller via the local area network (LAN) data bus. The RPM visually monitors the site from a distance. It monitors as many as six RF channels for forward and reflected power, six voltages and temperature. It has six open collector outputs.

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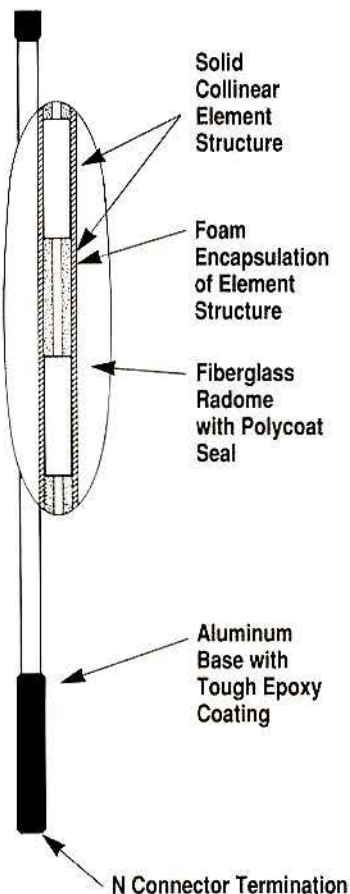
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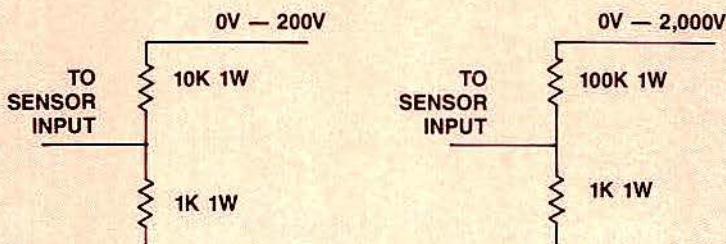
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In some cases, the power source is not 0Vdc to 20Vdc. Resistive voltage dividers can be used where the voltage exceeds 20Vdc. Some examples are shown below.



For applications requiring amplification, such as microwave AGC, amplifier drive and fuel level, the circuit shown below amplifies dc voltage so it is within 0Vdc to 20Vdc. A simple formula, $\text{gain} = R1/R2$, determines circuit gain.

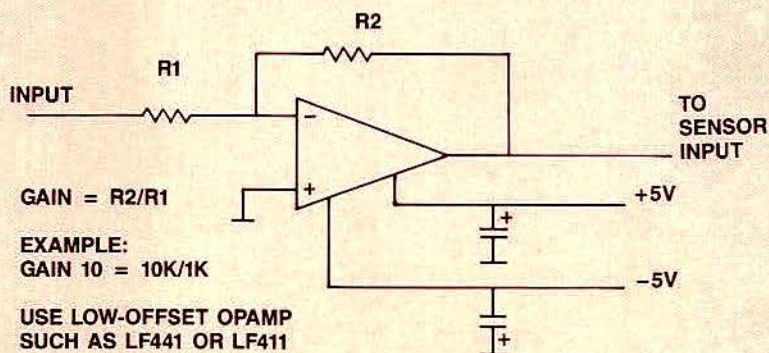


Figure 2. Six voltage sensor inputs can be connected to any voltage source, including power supply, batteries and solar panels. Upper and lower limits can be set for alarm purposes. These inputs have a range of 0Vdc to 20Vdc. Each input measures voltage independently. Where the power source is outside the range of 0Vdc to 20Vdc, a resistive voltage divider or an amplifier can be used.

stages, fans and air conditioners.

Each RPM must be connected to the LAN master via a 50Ω coaxial cable, such as RG-58. This cable allows a signal to transfer back and forth among the LAN master and remotes.

Remote network controller

The RNC can control as many as 40 RPMs. It determines which specific remote is causing the alarm. It interrogates the RPM to find out which sensor has caused alarm. With this information, the operator can verify the alarm manually and localize the problem. Then the right person with the right equipment can be dispatched to solve the problem.

The RPM can take measurements dynamically from all sensors: It can key

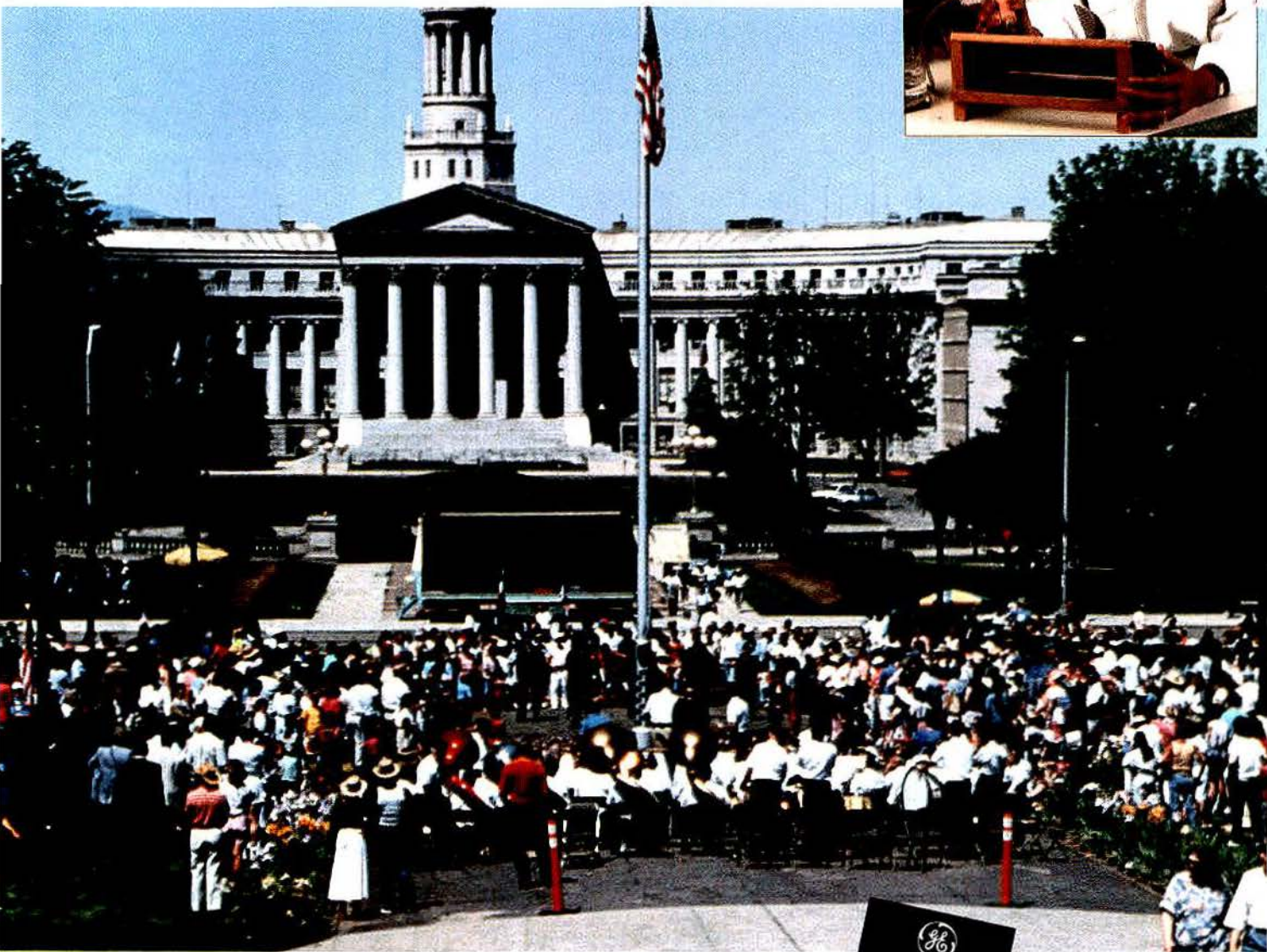
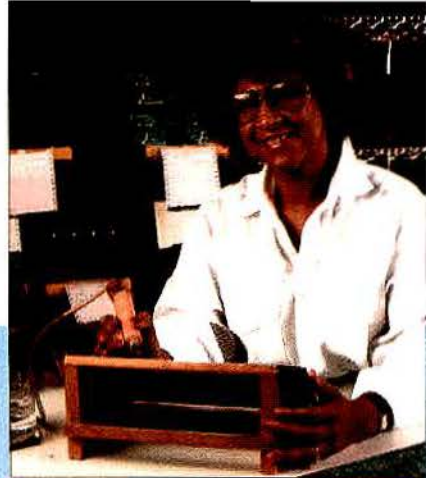
all six transmitters; take measurements; and report the results in approximately 10 seconds. Figure 3 on page 42 shows a typical screen display. With 50 RPMs, 240 channels can be monitored.

The RNC allows multiple companies to monitor remote equipment economically. As many as 10 users, one at a time, can access the network through-out the RNC over a single phone line. The RNC allows each company to have its own password for access to its own equipment.

The system manager assigns each company a password and an address for the remotes. Each company can have as many remotes as they need, as long as the total does not exceed 40.

This networking concept allows for easy expansion. As the need for more

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As a lead board assembler at Ericsson GE, Ruby Parrish is prepared to go to great lengths to help fulfill Ericsson GE's "zero defects" goal for EDACS. So are all our other employees.

When one million lives are on the line, she won't settle for less than the very best quality. We're sure you feel exactly the same way.

For facts about EDACS, plus a free booklet with true-life case histories, call Ericsson GE Mobile Communications Inc. at 1-800-GE-12345 or 804-528-7643.



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Voltage Sensor 01	13.6 Volts DC
Voltage Sensor 02	13.8 Volts DC
Voltage Sensor 03	14.0 Volts DC
Voltage Sensor 04	13.9 Volts DC
Voltage Sensor 05	13.6 Volts DC
Voltage Sensor 06	13.8 Volts DC

Power Sensor 01	67.5 Fwd	00.4 Ref Watts
Power Sensor 02	75.6 Fwd	00.5 Ref Watts
Power Sensor 03	72.5 Fwd	00.2 Ref Watts
Power Sensor 04	70.9 Fwd	00.2 Ref Watts
Power Sensor 05	69.5 Fwd	00.4 Ref Watts
Power Sensor 06	73.5 Fwd	00.1 Ref Watts

The door is closed

Figure 3. The RPM takes measurements dynamically from all sensors: It can key all six transmitters; take measurements; and report the results in approximately 10 seconds, as shown in this typical screen display. With 40 RPMs, 240 channels can be monitored.

Remote power monitoring system

MANUFACTURER'S EQUIPMENT

- ☐ Remote network controller.
- ☐ At least one remote power monitor.
- ☐ RF power sensors.

CUSTOMER-SUPPLIED EQUIPMENT

- ☐ Dial-up telephone line.
- ☐ Modems.
- ☐ Personal computer or terminal.
- ☐ RS-232 cable.
- ☐ RG-58 coaxial cable.
- ☐ Two-conductor shielded cable.



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equipment grows, so does the need to monitor the equipment. The RNC can operate with as little as one remote, and then grow with the equipment as needed. Alarms generated by the remotes can activate a dialing sequencer to call certain numbers, alerting a technician of trouble at the site. With a Hayes-compatible modem, the RPM can call a modem or pager.

The RPM and RNC have movable ears, so they can be mounted at any depth in a 19-inch rack. All sensor outputs use standard DB-25 connectors. The remotes are connected to the RNC via a single RG-58 coaxial cable, daisy-chained throughout the building. 

Circle (34) on Fast Fact Card



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Computerized service monitor applications

Automated test routines for two-way radios and cellular base stations serve as examples of how to use computerized service monitors. Several test setups and routines can be used to speed service and improve quality.

By Scott Swisher

Microprocessor-based service monitors are bringing automated service applications into common use. By automating repetitive tasks and by improving service quality, these monitors save valuable technician time,

whether they are used alone or in conjunction with other computers.

Early service monitors enhanced technician productivity by combining several instruments in one package. Later monitors incorporated microprocessors to make them easier to operate and to provide more features.

Test methods were manual: Button-

pushing and knob-turning controlled the monitor and the radio under test. At the time, most radios either lacked microprocessors or used them in basic control applications.

Service monitors and the radios they test are becoming more powerful through the increased use of microprocessors and computers. Monitors and radios are more like computers with RF circuitry than like radio equipment with computer components.

Cell-site optimization

Computer-controlled test and optimization systems are ideally suited to use for cellular base stations because cell sites have many channels, their setup adjustments require accuracy and the measurements are repetitive. Moreover, cellular base stations are designed to use a computer system for access and control.

Figure 1 on the left shows an automated optimization system for one type of cellular base station.

The system uses a laptop personal computer with dual RS-232 ports as its controller. RS-232 is used rather than IEEE-488 because no added boards are required in the computer.

The laptop personal computer is the ideal controller for cell-site optimization because the computer is required for other applications normally used with this particular base station. It is easy to

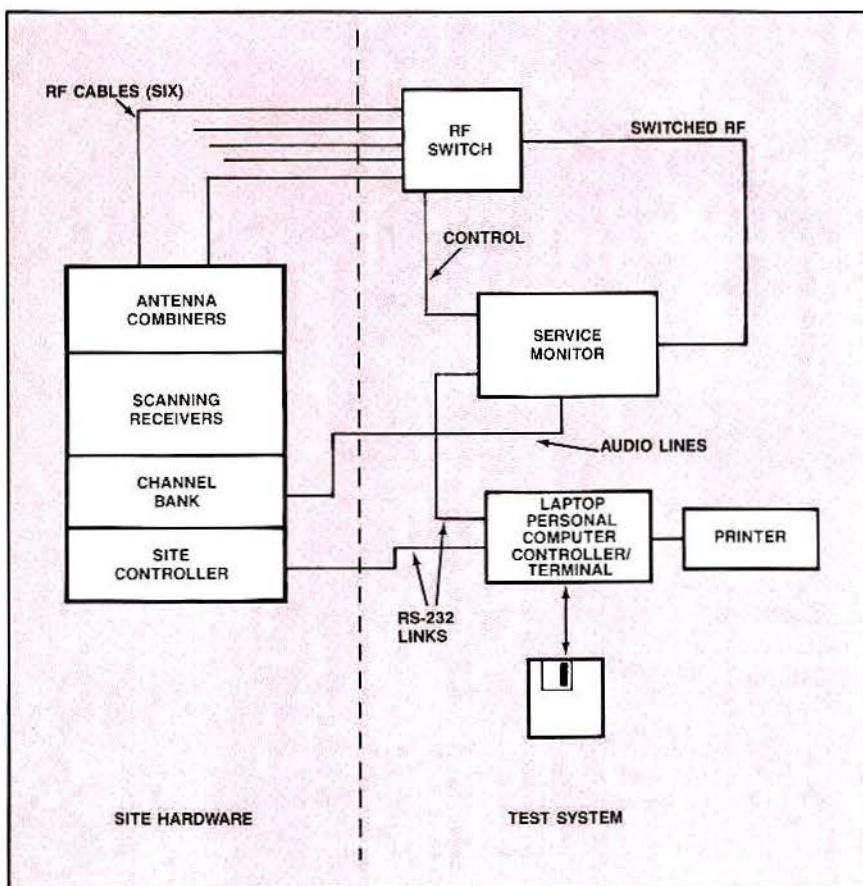
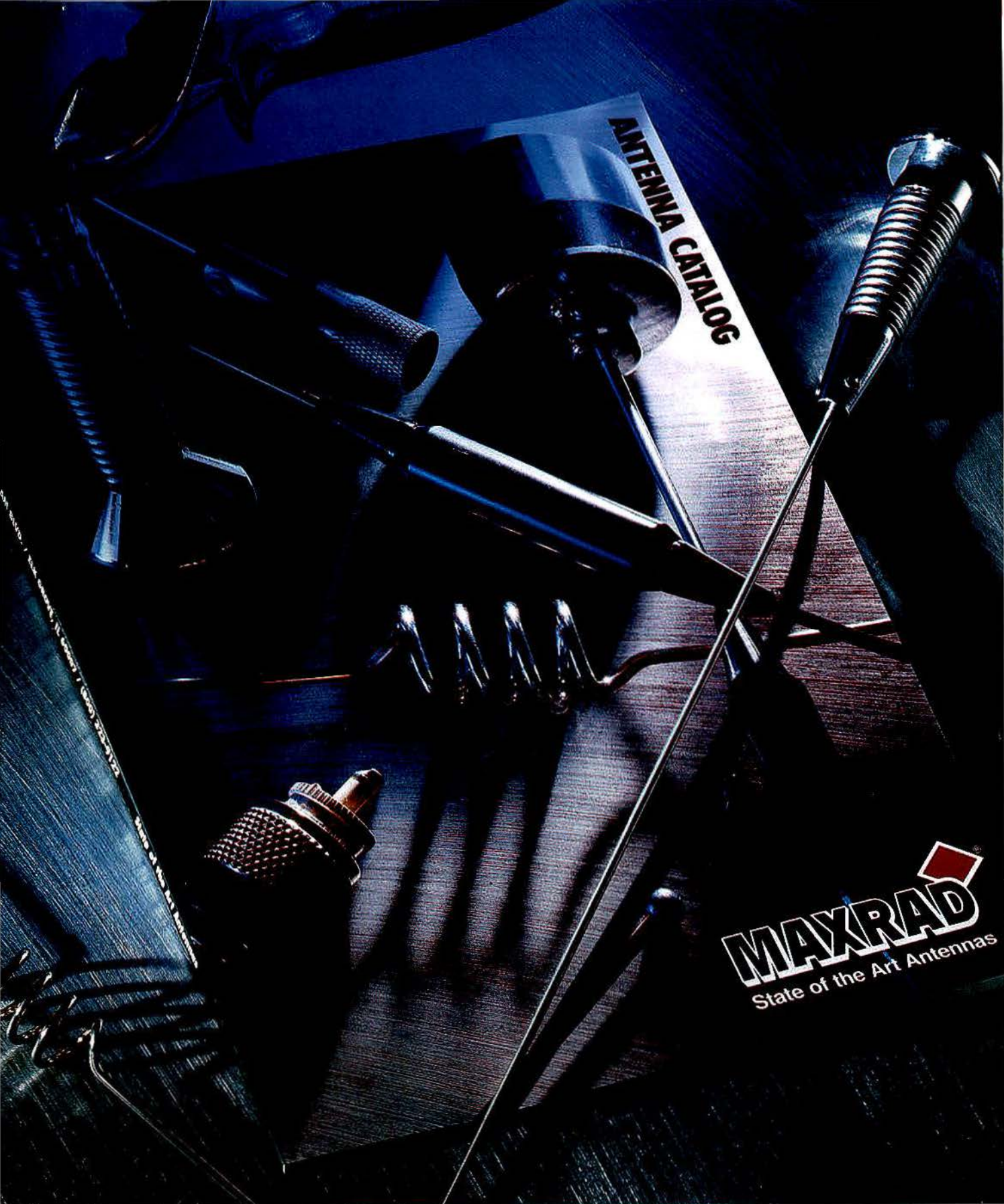


Figure 1. An automated optimization system for one type of cellular base stations uses a laptop personal computer with dual RS-232 ports. RS-232 is used rather than IEEE-488 because no added computer circuit boards are required.

Swisher is engineering manager for the Worldwide System and Aftermarket Products Division of the Land Mobile Products Sector at Motorola, Schaumburg, IL. The company's R-2600 service monitor and HD-II cellular base station are the monitor and base station used in examples in the article.



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Circle (36) on Fast Fact Card

develop and use control programs on the laptop, which includes an independent display and a printer interface. The computer offers a hard disk drive and low-cost floppy disk data and program storage.

The laptop computer sends operational commands to and receives data from the base station via the RS-232 port. A portion of this data, interpreted by the

laptop computer and shown on its liquid crystal display (LCD) informs the operator of the site setup and configuration.

The service monitor's RS-232 port allows the laptop to control and to retrieve test data from the monitor.

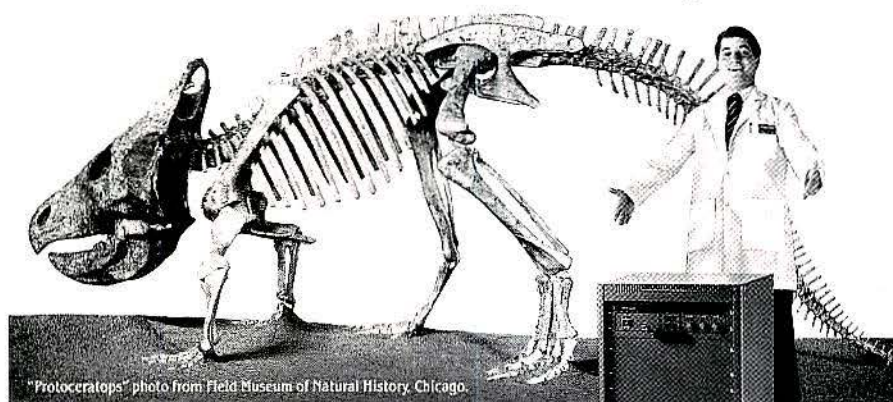
The laptop computer controls an interface in the monitor to operate an RF switch and to eliminate manual coax

switching. It runs a multipurpose program that allows the user to select from a function menu for maximum efficiency.

In the test mode, the laptop computer places the monitor and base station in various test states and steps through the optimization procedure. When needed, a prompt appears on the screen to direct the user to perform certain functions. Additionally, the RF switch automatically selects the appropriate antenna port.

Reading site channel data from the

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Table 1—Some of the automatic tests that can be run on cellular base stations.

- ☐ RDM tests
- ☐ PA output check/adjustment
- ☐ signaling channel tests
- ☐ voice transceiver tests
- ☐ scan receiver tests
- ☐ BSC common equipment tests
- ☐ alarm tests

equipment into the laptop avoids the need for manual data entry. Site documentation and test results are stored on floppy disk. The user can print or display the information.

This process saves technician time and improves quality by optimizing each base station exactly the same way every time and "by the book."

Table 1 above lists some of the automatic tests that can be run.

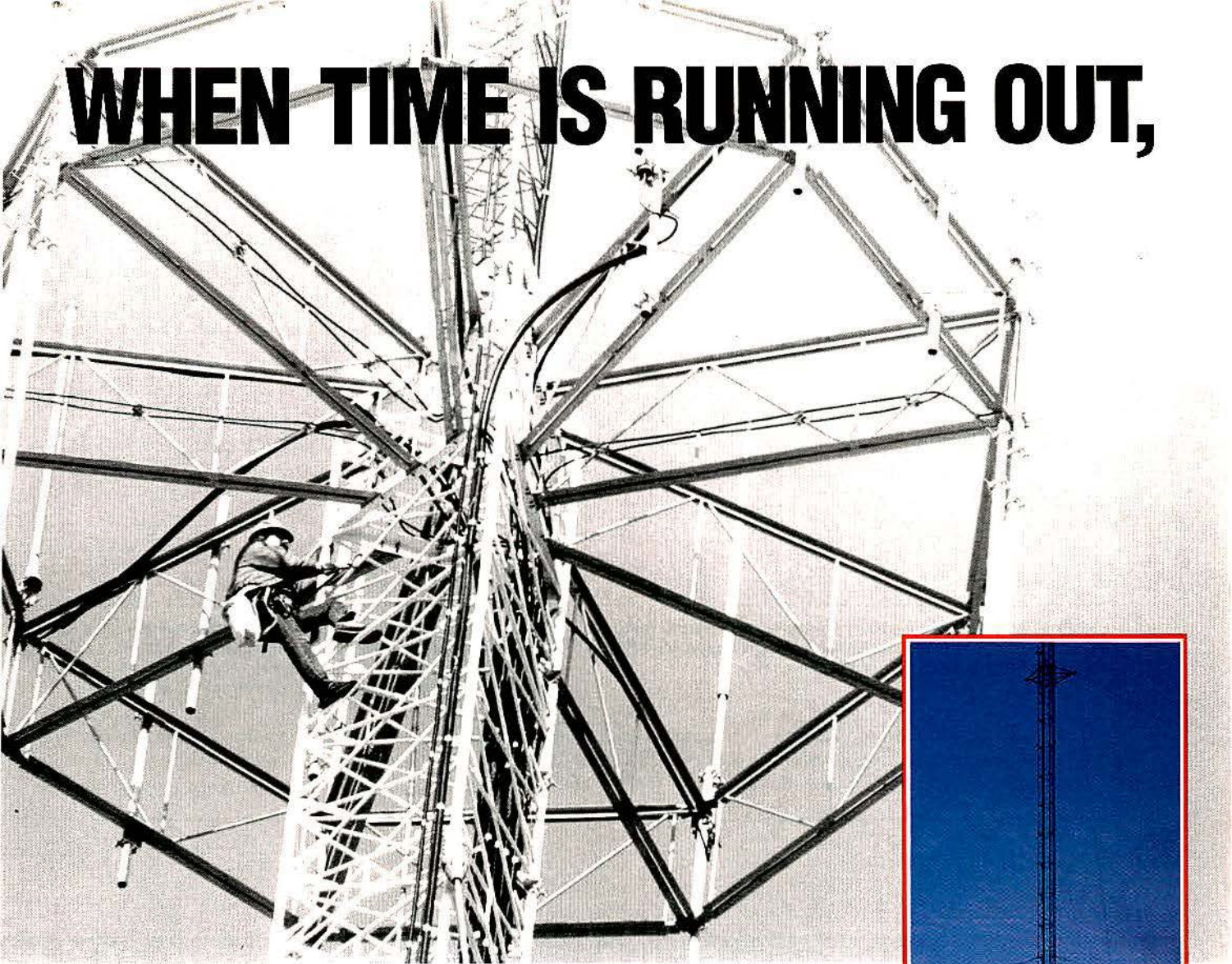
A terminal emulation mode in the program allows the operator to take control of the station from the laptop computer.

A calibration menu allows the monitor to use a loopback through the RF switch and cables to calibrate the losses involved, thus ensuring even greater accuracy.

Radio test and setup

Since my participation on the team that designed the first two-way FM radio that included a microcomputer, the

WHEN TIME IS RUNNING OUT,



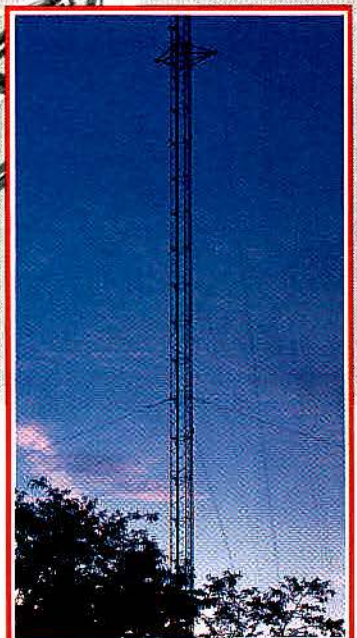
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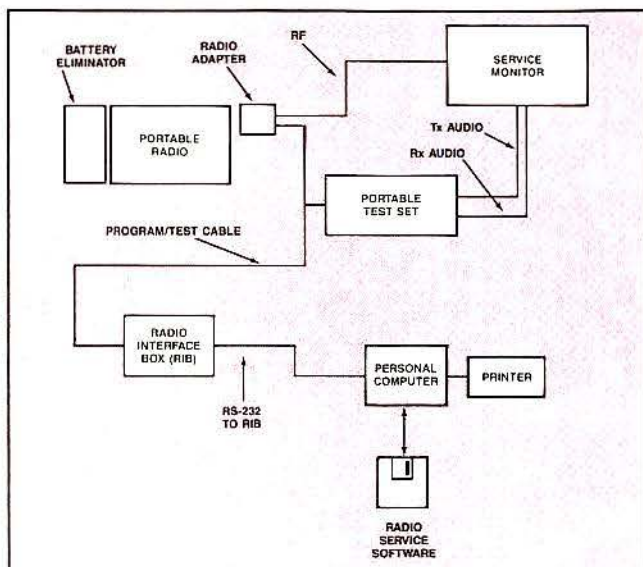


Figure 2. A typical programming setup for a portable radio includes a radio interface box (RIB), which translates RS-232 levels from the computer to radio logic levels.

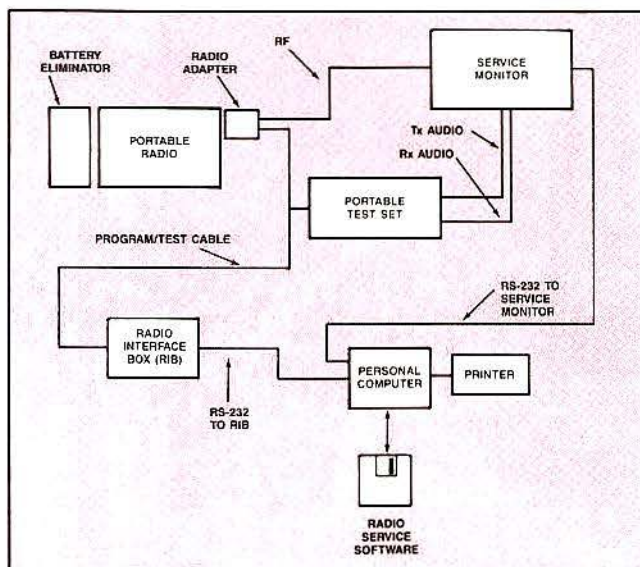


Figure 3. This automated radio tune and test system uses radio service software running on the personal computer. This setup allows the RS-232 link to the radio to control and set up the radio as well as to manipulate conventional radio user data.

use of microcomputers in communications radios has become commonplace.

The first uses were for synthesizer,

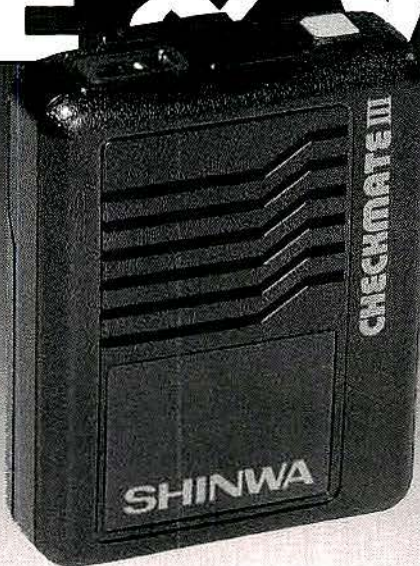
continuous-tone controlled squelch system (CTCSS) and digitally controlled squelch (DCS), and radio control.

The original radios used fusible-link, programmable read-only memory (PROM) to store user-dependent data.

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Checkmate III features:

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unipage

These PROM modules required unique programmers to load and read radio data.

In the 1980s, a personal computer loaded with radio service software (RSS) became the means to load and read user data in a radio's electrically erasable PROM (EEPROM).

Figure 2 on page 48 is a block diagram of a typical setup for a portable

radio. The radio interface box (RIB) translates RS-232 levels from the computer to radio logic levels.

It soon became apparent that the radio memory could store radio alignment information, such as deviation adjustment data, once those items were under the control of the radio microprocessor. This data could be programmed in the factory or in the service shop us-

ing the RIB link. For multichannel radios, however, conducting such a procedure manually can become time-consuming.

Figure 3 on page 48 is a block diagram of an automated radio tune and test system. Radio service software running on the personal computer allows the RS-232 link to the radio to control and set up the radio as well as to manipulate conventional radio user data. An RS-232 link to the service monitor allows RSS software routines to control and receive data from the service monitor.

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Table 2—Automated capabilities of the integrated radio tune and test system.

TUNING

- ☐ transmit frequency
- ☐ transmit power
- ☐ maximum deviation
- ☐ receiver front-end bandpass filter
- ☐ carrier squelch break

TESTING

- ☐ transmit frequency
- ☐ transmit power
- ☐ maximum deviation
- ☐ CTCSS deviation
- ☐ 12dB SINAD
- ☐ receiver distortion
- ☐ carrier squelch break

The user thereby can test and adjust the radio, as well as print out results of the procedures. Table 2 above lists the automated capabilities of the integrated system.

Future

As the use of this technology develops, programs may be written that program, tune, test and troubleshoot radios. Radio test data for mobile fleets could be stored on disk and compared with fresh test data to predict failures and observe degradation trends.

The increasing potential of computers, communications service monitors and the radios they test offer the service community great potential to automate tasks, improve service quality and provide more cost-effective service to the communications user.

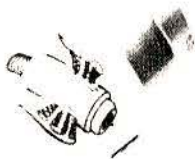


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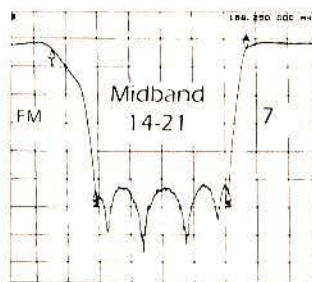
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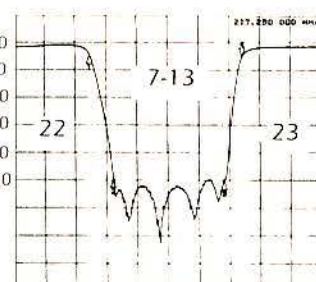
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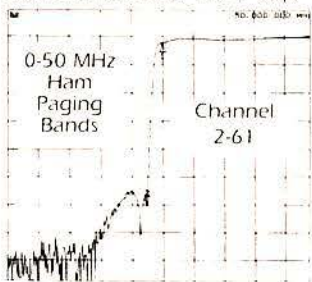
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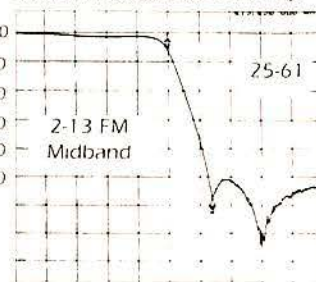
5KMT-A/H Channel 14-21 Trap



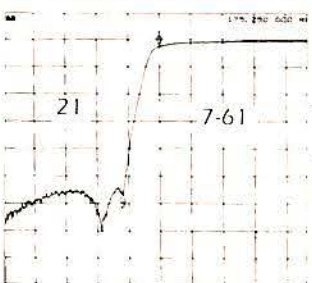
5KMT-7/13 Channel 7-13 Trap



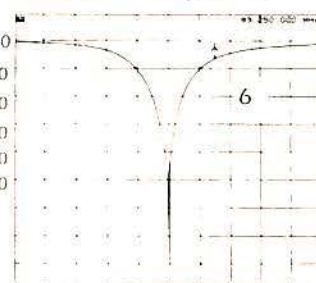
5KHP-55 Low Radio Band Trap



5KLP-216 Super/Hyper Trap

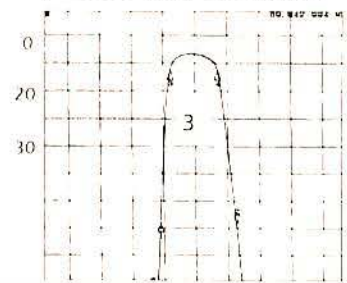


5KHP-174 Low/FM/Mid Trap



5KVS-5 Channel 5 Sound Trap

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5KBP-3 Channel 3 Pole Bandpass Filter

Cellular carriers to offer data communications

Five cellular mobile telephone carriers plan to offer data communications services over their networks. The carriers, Ameritech Mobile communications, Bell Atlantic Mobile Systems, Contel Cellular, GTE Mobilnet and Nynex Mobile Communications, manage networks that serve nearly 2 million customers.

Complex tests digital simulcast control

Complex Systems, Quincy, IL, has tested its C-NET digital simulcast control system with three different digital satellite channel offerings. Based on test results, Complex has approved the satellite channel offerings for use with its C-NET system.

The satellite channels include:

- SpaceCom Systems FM Cubed.
- SpaceCom Systems FM Squared.
- Microspace Communications FM Squared.

Ericsson GE obtains contract from Dallas Fire Department

The Dallas Fire Department has signed a contract for a 10-channel digital access communications system from Ericsson GE, Lynchburg, VA. The department's purchase includes \$4 million worth of equipment to upgrade its conventional radio system to a trunked communications system.

The upgrade includes:

- 13 dispatch consoles.
- more than 200 portables.
- more than 400 Rangr and FMD mobile radios.

The system will cover a 400-square-mile area and is scheduled for completion by the fall of 1992.

McCaw completes Texas regional paging system

McCaw Communications Houston office has completed its wide-area regional paging system. The system allows McCaw subscribers to be reached

within the Southeast Texas coverage area via one seven-digit number. The cost of the wide-area network is estimated at \$1 million.

Panasonic offers upgrade for code programmer

A free upgrade for the Panasonic EY-196 code programmer allows the programmer to work with the company's new pagers. Owners of the code programmer may ship their units to Minilec Service, 20813 Plummer St.,

Chatsworth, CA 91311; phone: 800-222-6075.

Minilec, Panasonic's factory authorized service representative, offers a typical five-day turnaround time from receipt of the code programmer.

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The ZML is smart, too. A timed dialing buffer always transmits digits calmly and efficiently, even if the user has dialed hastily or erratically.

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ZETRON



Dispatch Communications acquires VA two-way firm

Dispatch Communications of the Mid-Atlantic, based in Bethesda, MD, has acquired Hampton Roads Two-Way, Chesapeake, VA. Hampton Roads provides mobile radio services to the greater Norfolk-Virginia Beach market. Ritzel Communications, Englewood, CO, a company specializing in mobile communications mergers and acquisitions, represented Hampton Roads in the merger.

Larsen names reps

Larsen Electronics, Vancouver, WA, has selected Horizon Comm Sales, Rowlett, TX, as a sales representative in Arizona. Great Lakes Communications Sales, Port Clinton, OH, will represent the company in Indiana. Kentucky, Michigan, northern New York, Ohio, western Pennsylvania and West Virginia. R.P. Moses & Company will cover northern New Jersey, New York City and Long Island.

Pocket-Fax commences alpha messaging service

Pocket-Fax, Providence, RI, has launched its nationwide alphanumeric messaging service and plans to add more radio common carriers to its affiliate base.

Bird celebrates 50th anniversary

In April 1942, Bird Electronic Corporation, Solon, OH, was formed by J. Raymond Bird to design and to build the highest degree of accuracy feasible into military communications RF power measuring equipment.

By continuously applying itself to the management of problems stemming from expanding use of coaxial line systems, the young company quickly found itself serving the burgeoning post-war commercial mobile radio and broadcast transmission markets as well.

An early success was a high-frequency coaxial line resistor that came to be known as the Termline reflectionless termination, or dummy load.

The company has contracted with carriers representing more than 1,200 cities in the United States and Canada. Major U.S. cities were on-line in November 1991.

Another successful product was the Thruline wattmeter, which includes a short section inserted in a coaxial line to measure power and VSWR without degrading transmission or causing objectionable reflections.

Today, Bird makes 10kHz-to-2.5GHz precision Thruline RF power measurement instruments and precision digital wattmeters and calorimeters, along with RF loads, attenuators, switches and directional couplers.

The company still is owned by the Bird family, which is active in the business. Bruce Bird, executive vice president, is the founder's son.



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ZMX

The ZMX from Zetron is the smartest, most advanced DTMF microphone in the world today. A powerhouse of programmable features -- tough as nails. It knows how to adjust to meet changing requirements.

Several intelligent dialing modes are available. With the super smart cellular mode, for instance, a user gains access to the public telephone system by simply dialing the desired number and pressing *. How's that for convenience? Automatic ANIs, autodials, and other superior features round out this mic's impressive resume.

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ZETRON

Finding good techs and keeping them happy

By Thomas Green

NABER frequently surveys its members to discover patterns related to technician hiring and retention. Survey results help certified technicians to understand how employers recruit technicians, what characteristics employers look for in the technicians they hire, incentives employers use to retain technicians and what employers should do to ensure that technicians become an integral part of the shop.

Employers tend to recruit new technicians from the local community, from four-year colleges and from vocational schools. Recruiting on school campuses ensures that employers will find a technician with certain skills and education.

Additionally, employers advertise in local newspapers and in trade journals with classified advertising. But according to NABER, more than 60% of the technicians it surveyed found their cur-

rent jobs by word of mouth. Despite this statistic, many employers advertise to make sure they interview candidates with the desired skills and education.

Because employers cannot be 100% certain that they hire the right technician for the job, they depend heavily on an interview and a test to predict a candidate's potential performance.

Hiring methods differ, but some aspects of the process are common. If you are a technician, here is a list of what you should do and expect at the job interview:

1. The employer will ask prepared questions in an effort to reveal your skills, interest in the job and motivations.

2. Be as alert as possible because employers will be at their best. Most employers interview many candidates because they want to hire the best person. Make a positive first impression.

3. Be prepared to take a skills test. A written test, a practical hands-on test

or both are methods employers use to inventory your skills and experience.

4. Obtain background information on the company that is hiring. Employers are likely to ask you questions intended to reveal your perception of a good supervisor and a good place to work.

It is important for you that your preferences regarding management practices are similar. When you know at the interview how the company is run and what its strategic goals are, it will make a positive impression.

5. Make sure you understand the company's compensation plan and benefits. Employers should give this information at the first interview.

Green is an instructor and communications manager of communications electronics at Ranken Technical College, St. Louis. He serves as ACT's volunteer leadership council chairman. ACT, the Association of Communications Technicians, is a membership section of NABER, the National Association of Business and Educational Radio.

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Molly Gerry
Two Way Communications Svc.
Portsmouth, New Hampshire

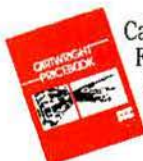
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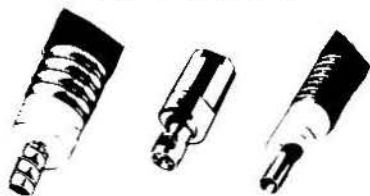
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ACT update

If you do not receive the information, ask for it. Asking for the information is a great way to let your prospective employer know that you are interested in working for the company.

Once technicians begin their employment, employers can take several steps to keep them satisfied. These steps relate to the fact that many technicians have increased their skills through the years, and therefore their demands to be treated as professional members of the team have increased. Some progressive companies have found that a positive work environment can be created by:

- ▶ establishing company and individual goals. Technicians have worthwhile ideas, and they can be recruited easily to help to develop shop goals.
- ▶ maintaining open lines of communication. Technicians should be listened to for their positive, as well as their negative, comments. They have first-hand knowledge of how they can work more efficiently.
- ▶ providing continuing challenges.

Technicians are at their best when they are given the opportunity to improve their professional level by learning new skills or taking special classes.

▶ making performance evaluations a regular, on-going process. The technicians' evaluations should not only critique past performance but set goals.

By encouraging technicians to take on new challenges and by reinforcing their value within the company, employers help to ensure the shop's continued success.

Information

Technician certification examinations will be offered at 120 sites in 43 states on the following schedule:

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Circle (47) on Fast Fact Card

Service companies can take steps to prevent interference

Judah Mansbach, an electronics engineer with the FCC Field Operations Bureau New York office, said service companies that rent space for equipment and antennas on someone else's site should ensure that the site owner or manager compiles adequate information about users on the site.

"For example," he said, "at the World Trade Center they do an intermod study before they permit you to put your transmitter up there to make sure there won't be any intermod problems. An intermod study is helpful whenever a service company is going to rent space somewhere. And most site managers do it. They will check to see whether there will be any intermod problems when they lease space on a tower."

He said service companies especially should check older transmitters for parasitic oscillations that may cause harmful interference.

He recommended that all repeaters be

equipped with automatic station identification equipment.

Another suggestion Mansbach has for service companies and their customers is: "If they get a letter from us, cooperate with us all the way and consider us a friend, rather than the enemy. As far as fines are concerned, I'm not out to solve the national debt. This office certainly is looking for compliance. We'd rather have compliance than to have to issue fines or violation notices. Processing notices is a time-consuming operation. We never know in advance whether the case will end up in court. Nevertheless, if need be, we will get compliance any way we can."

He said licensees who come to the FCC for help in resolving problems do not risk receiving violation notices as a result of coming forward. "This office will work with the licensee until it is resolved. But if we get complaints and have to take the initiative and come out

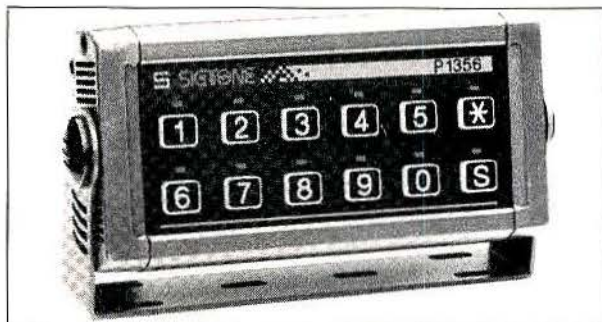
there on our own to find the problem, I'll throw the book at them. Discuss your problems with us, and we'll help you. This office is not out to issue violations."

Frequency coordinator

FCC New York office public service specialist Kevin McKeon commented about the frequency coordinator's role in resolving land mobile radio interference: "Some people don't know that it is the frequency coordinator's job to put new licensees on the air. Then, if through that coordination there is a congestion problem, the coordinator should be contacted about that."

In some cases, people haven't been contacting the coordinator. We recommend they do so because something about the coordination may have been incorrect. If the new station comes on the air and as a result of his heavy use of the frequency, a complainant cannot

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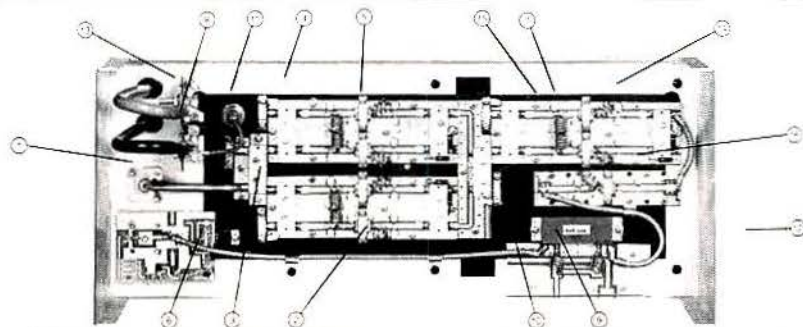
- Simple installation - No soldering, wire cutting or crimping involved
- Provides remote channel indication and channel changing capability.
- Does not require B308 option be installed
- Remote can put radio into or out of scan mode, if radio has the scan feature.
- Remote transmissions heard over radio speaker
- Remotes hear transmissions made using radio microphone.
- Uses any two wire voice grade circuit.



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Regulating technology

operate at all, then there is a problem."

Mansbach offered an example of such a post-coordination problem: "A radio-equipped car service with a 100-unit fleet will be dispatching on the air continuously. If that service is put on a channel with a business user who only has to call one truck twice a day, the business user will not be able to get a word in edgewise. If I were such a customer, I never would allow my radio service company to put me on a channel with a car service.

"Let's say he does anyway. I'm trying to call my truck, but I cannot get through because the car service is on constantly. So I call the FCC and complain. 'The car service must be doing something wrong; I can't get a word in edgewise.' The fact is, the car service is doing nothing wrong. It is just doing a lot of communicating.

"This becomes a co-channel problem. Who is to blame? Not the FCC. The service company? Maybe. The service company put the customer on the air and recommended that frequency. Is the frequency coordinator to blame because he coordinated the frequency? Maybe. It is the frequency coordinator's function to add new licensees without causing co-channel interference to existing licensees."

Mansbach said occasionally information reaches him "through the grapevine" about illegal operations. As an example, he mentioned a licensee that transferred his operating authority to another entity for a fee without going through the required paperwork.

"An illegal transfer may be attempted when the new operator cannot meet the eligibility requirements for the radio service in which the seller is licensed," he explained. "Having radios on the seller's frequency was desirable to the buyer because there weren't too many other licensees on the channel—it was, essentially, a clear channel." Mansbach stated that he checks out all such allegations, especially when he has confidence in the source. "Sometimes," he said, "I strike pay dirt."

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Circle (52) on Fast Fact Card

Readers' choice

Of all the new products and services in the October 1991 issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

120-channel marine radio offers 25W output in VHF

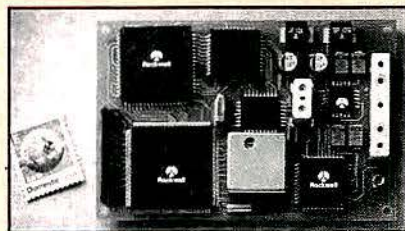
Model 78-101 25W VHF marine radio contains a large LCD readout and reversible front panel for under-dash or overhead mounting. The **Midland International** radio offers international or Canadian and U.S. frequency coverage and an additional 10 NOAA weather channels. The radio's dual watch feature permits monitoring of distress Channel 16 and any other channel selected from the main dial. The radio also has screw-in mic, in-



stant Channel 16 and squelch range control.

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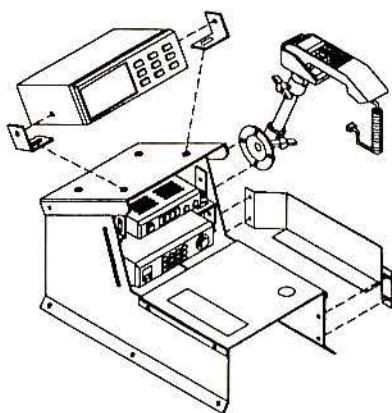
Satellite receiver module boasts five channels



The NavCore V global positioning system (GPS) receiver module from **Rockwell International** includes five channels in a compact unit. GPS is used for vehicle position and location information and marine uses.

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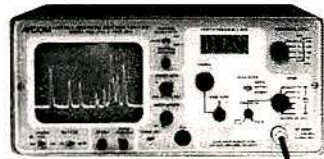
AVCOM's New PSA-65A Portable Spectrum Analyzer

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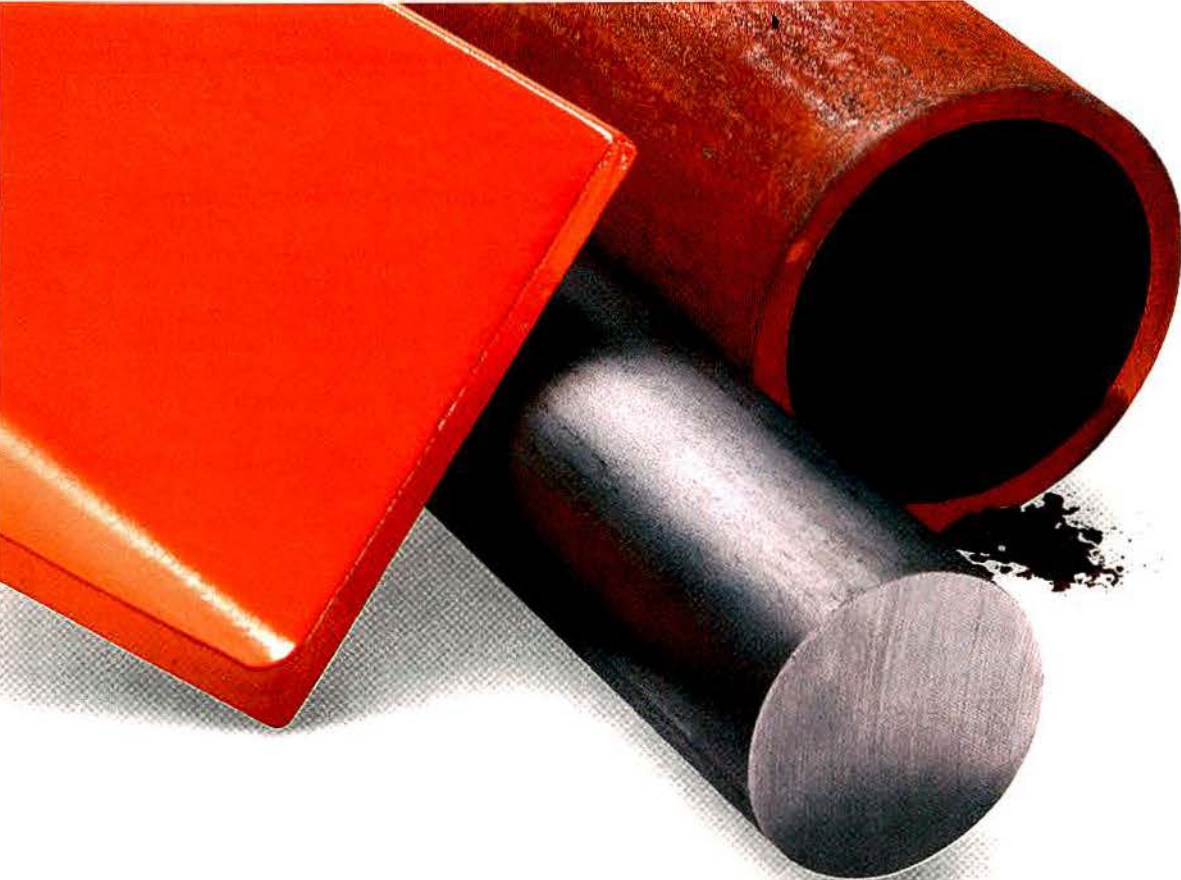
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Overall Tower Sway	1.0x	1.35x	1.17x
Wind Resistance (Area exposed to wind)	1.0x	1.64x	3.64x
Vulnerability to Rust (Percent of member that is lost if 1/16" rusts away)	9%	37%	29%
Freezing Water	Not an issue.	Possible to get trapped, freeze and split leg.	Not an issue.
Price Comparison (Based on several tower designs)	100%	100%	115%

Source: Paul J. Ford & Co. Engineering, Columbus, Ohio.

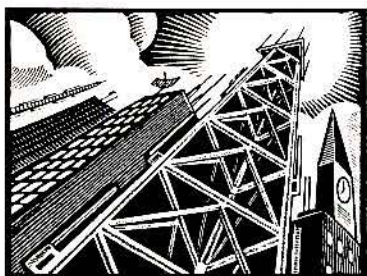
Scenario: 100 Kip Load on 36KSI Steel with a 5' unbraced length. Shape factors are 0.6 for rounds and 1.0 for flats. Comparable strength members were selected to compare the performance features of solid, tubular and angle steel leg towers. The preceding table illustrates the performance characteristics of a 2 3/4" solid leg, 4.5" O.D. x .337" tubular leg and 6" x 6" x 7/16" angle tower leg. Once again, these members were selected because they are of comparable strength.

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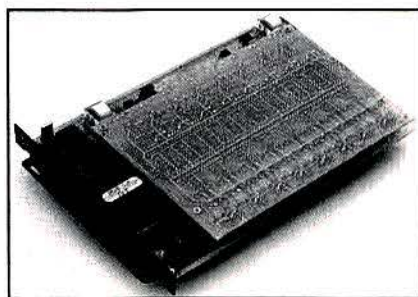
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Circle (56) on Fast Fact Card

New products

Audio path equalizer helps simulcast communication



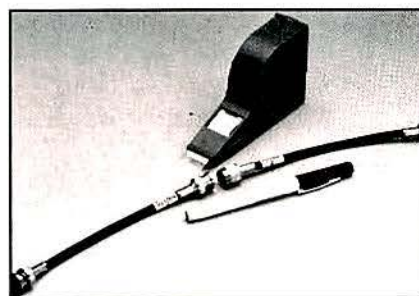
The 2042 equalizer system from Convex includes equalizer cards for each audio path controlled from a standard PC at a central site. The audio path equalizer for simulcast communications eliminates phase difference and provides a flat frequency response across the entire bandwidth for clear audio throughout the overlap area.

Circle (376) on Fast Fact Card

Write-on tape eases cable, wire labeling

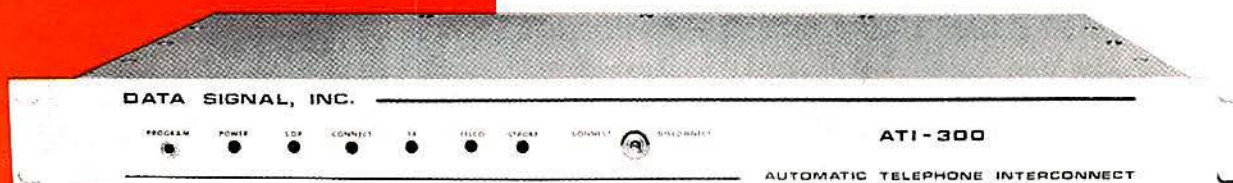
The 3M write-on tape system available from Jensen Tools suits cable and wiring labeling. The self-laminated labels for documenting system and future ID information are durable and resistant to dirt, oil and heat. The system includes a tape dispenser, pressure sensitive tape and a permanent marking pen. Each roll of tape includes 250 labels.

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And all test results can be printed out in an easy to read service record for your customer.

With all the competition for cellular business, Wavetek puts you ahead of the pack.

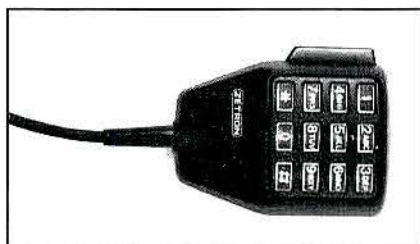
The CT3500 makes your job faster, more precise, and more enjoyable. Call Wavetek for a test drive. 1-800-245-6356.

Circle (58) on Fast Fact Card

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New products

Backlit mic sports heavy-duty PTT switch



The ZMX backlit mic from Zetron featured illuminated keys, each by its own internal LED. The mic includes a heavy-duty PTT switch that is rated for 30-million uses without failure. The mic is programmable from the keypad.

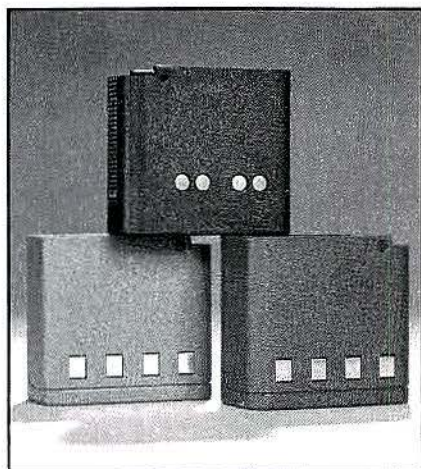
Circle (447) on Fast Fact Card

SMR software allows group-to-group calling

Version 2.2 SMR software from, AmeriCom allows group-to-group calling; memory allocation; roamer mask; and other control features.

Circle (432) on Fast Fact Card

Nickel metal hydride batteries fit portables



Nickel metal hydride batteries from Motorola Worldwide System and Aftermarket Products Division fit Motorola Saber, MTX800/900, MT1000 and HT600 portable radios. The nickel metal hydride rechargeable batteries offer a 30% increase in capacity over NiCd batteries of the same size.

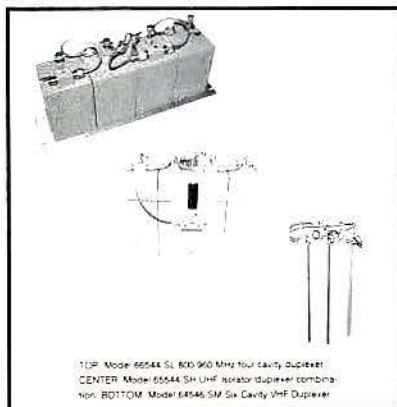
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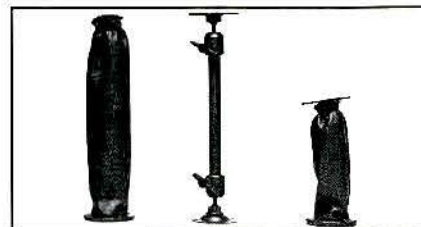
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Leather cover fits pedestal mounts



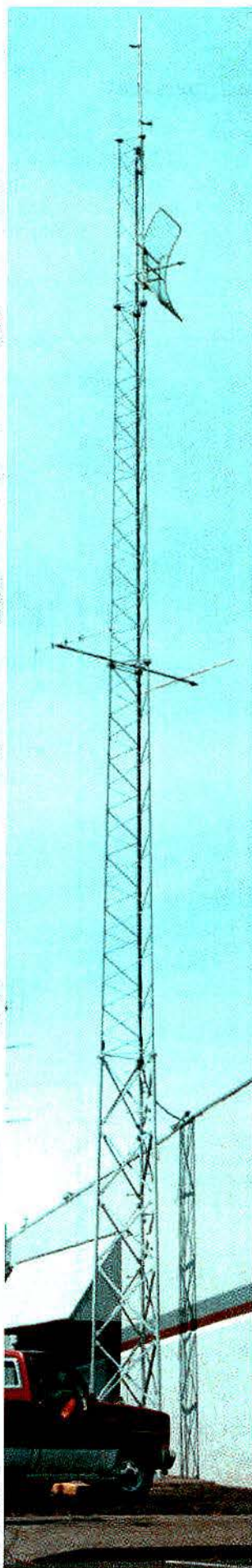
The boot leather cover from SMC Electro-Mount is available for the company's 6-inch, 8-inch and 10-inch cellular phone pedestal mounts with either Allen screws or T-knobs.

Circle (333) on Fast Fact Card

Circle (60) on Fast Fact Card

MICROFLECT'S 700 Series Light-Weight Towers

Microflect's 700 Series towers are available in heights from 10' to 160'. Greater height can be attained when adapted to the top of an 800 Series tower.



Microflect's 700 Series tower line has been designed specifically for light-duty applications, such as cellular, land mobile, UHF/VHF, and 18 & 23 GHz systems. This tower is available in 153 configurations, giving you more application versatility and adaptability than any other structure of its kind.

The features of this tower series include:

- three-leg configuration
- 10' to 160' heights using standard 10' modules
- 12" to 76" wide top
- base widths from 84" to 13"
- a comprehensive line of tower accessories including pipe mounts, grounding, lightning protection kits, and waveguide support components.

This series provides a complete line of light-weight self-supporting towers, backed with the same assurance of quality expected from all of Microflect's products.

For additional information, contact Microflect's marketing department at P.O. Box 12985, Salem, OR 97309-0985, telephone (503) 363-9267, FAX (503) 363-4613. A free copy of the 700 Series Self-Supporting Tower catalog and its price list will be sent upon request.



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New products

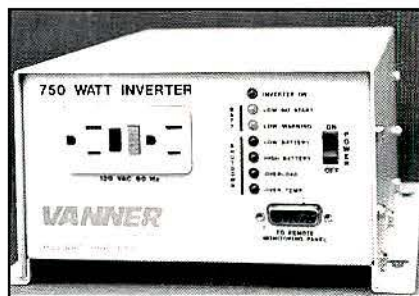
Paging program enables text messages

The ZAPP alphanumeric paging program works with an IBM-compatible PC to allow operators at multiple VDTs to create and transmit text paging messages to alphanumeric pagers. The **Zetron** program maintains a database of the pager users. Canned messages can

be selected, as well, for transmission. Features include previous page recall, on-disk logging, password protection, automatic paging at a predetermined time, and paging by name, company or pager ID.

Circle (508) on Fast Fact Card

Inverters deliver 750W of continuous power



The VannerLite 750 dc-to-ac inverters deliver 750W of continuous power and come in 12Vdc and 24Vdc models. The **Vanner** inverters feature a system monitor LED display for battery and inverter status; transfer switch; and a ground fault circuit interrupter outlet.

Circle (299) on Fast Fact Card

VHF hand-held transceiver comes with NiCd pack

The Procom M22 2W and two-channel VHF hand-held transceiver comes with one set of crystals installed on channel one and a rechargeable NiCd battery pack. An optional set of crystals can be factory-installed on channel two for the **Fanon Courier** radio.

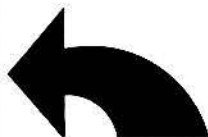
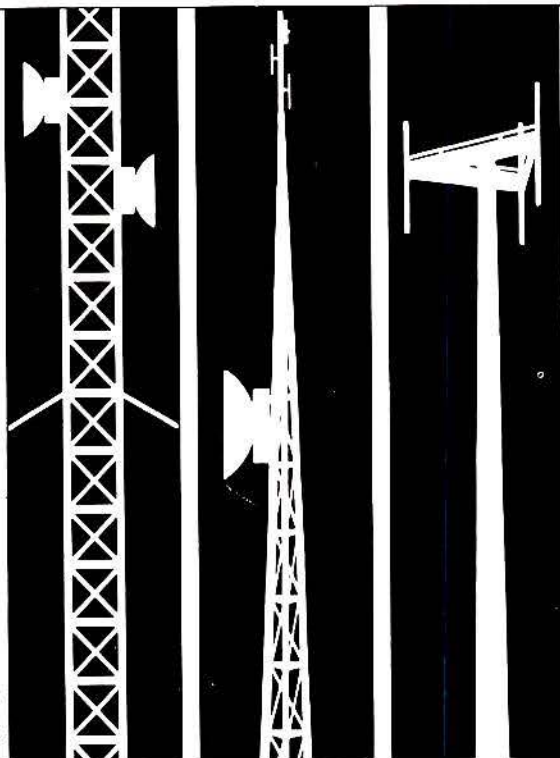


Circle (379) on Fast Fact Card

PC software for decoder enhances paging messages

PC software for the Verifier paging decoder allows the capture and storage of messages from an unlimited number of pagers. The **Hark Systems** software may be substituted for the standard statistical software supplied with the Verifier. The software can find a pager cap code by listening to a channel and watching for a match to a message string entered on the computer screen.

Circle (437) on Fast Fact Card



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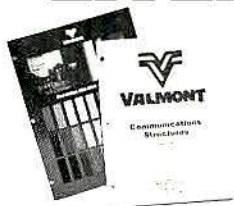
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885TT DTMF – QUALITY THAT'S AFFORDABLE. The 885TT gives you an unbeatable combination of economy, dependability, audio quality, and ease of use. It's a continuous-tone DTMF microphone that sets new standards for value and performance.

Features include:

- Illuminated keypad – designed to last and requiring no extra wiring in most cases.
- Million-Cycle Leaf Switch™ – a Shure exclusive, giving you longer trouble-free use.
- Positive tactile feel keys and audible tone to help make number entry easy and accurate.
- Externally adjustable audio and DTMF levels for easy installation.
- Tailored frequency response and Top-Talk Sound Channels™ provide optimum clarity and intelligibility.

890TT DTMF – THE PROGRAMMABLE CHOICE. The 890TT is a burst-mode DTMF microphone with all the features of the 885TT, plus programmable functions, including:

- Auto-dial feature with ten memory locations (up to 16 digits each).
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- Lithium battery keeps the programmed memory safe for years.

590T – A DYNAMIC PERFORMER. The 590T, featuring a Shure amplified dynamic cartridge, is ideally suited to a wide range of mobile installations. Tailored frequency response provides optimum voice articulation while it discriminates against other sounds. The 590T is a workhorse designed to provide trouble-free service under the harshest conditions.

ALL FEATURE THE SPEED, VERSATILITY AND COST-SAVINGS OF MODULINK® TECHNOLOGY. All three mics are part of Shure's patented ModuLink System 1. Modular cordsets allow these mics to plug instantly into virtually all of the most widely used radio transceivers with no hardwiring – making installations and cable replacement, literally, a snap. Replaceable cordsets also help reduce inventory and lower repair costs.

THE FINAL WORD ABOUT QUALITY. At Shure commitment to quality is not simply talk. You'll be able to see and feel the quality of our mics as soon as you pick one up. Because we test them tougher, our mics last longer and perform better.

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COMMUNICATIONS PRODUCTS

Circle (63) on Fast Fact Card

New products

Mobile system tower comes in 85-foot size

The tower for FWT's mobile communications system is available as high as 85 feet, almost twice the size of the previously available tower. The tower is self-supporting and can be constructed with the option of a solid bar, tubular or angle leg.

Circle (337) on Fast Fact Card

Transportable phone comes in waterproof plastic case

The WorkPhone from Sandel Cellular offers 3W, rugged construction and a 7Ah lead-acid battery. The transportable phone includes a Motorola 2600 unit, a dc-dc converter, low-voltage cut-off circuitry and a hermetically sealed waterproof case.

Circle (380) on Fast Fact Card

Talk-back pager comes in UHF, VHF models

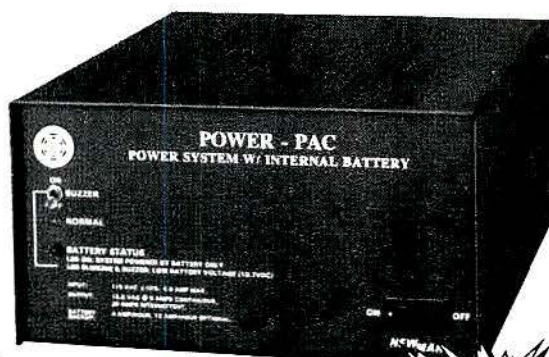


The talk-back pager operates on the most common on-site paging systems and is available in VHF model 70-132 or UHF model 70-232. The Midland LMR pager boasts 2W output power in its talk-back mode. It has built-in programmable CTCSS encoding and a two-tone decoder. The pager meets military standard 810C and D.

Circle (386) on Fast Fact Card

How To Tell If Your Base Station Needs The NEWMAR POWER-PAC...

PULL THE PLUG



If your communication system dies when you have an interruption in AC Power, you need the NEWMAR™ Power-Pac. Its a 20 amp power supply with a back-up battery built in which acts as an uninterruptible DC supply when AC power is down.

The internal maintenance free batteries are floated at full charge by the power supply. If AC power is interrupted, the batteries automatically take over powering the radio. This assures your system is up when it is needed most - during a power outage.

The Power-Pac comes in an attractive, black, 6" x 9" x 10" case and contains a sealed deep cycle 7 amp/hour battery which can operate a 25 watt radio for up to two hours based on a 20% TX/RX duty cycle. Reserve power capacity can be doubled by installing a second internal battery. Separate output terminals are also provided for connecting external batteries to increase back-up capacity.

Audio and visual warnings on the front panel alert the operator when the system switches to back-up power and give reserve power status.

So if you want to keep your communication system up, even when AC power is down, put in a NEWMAR Power-Pac. Suggested retail price is \$275.00

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Circle (64) on Fast Fact Card

Rechargeable battery packs fit Fujitsu portables



Nickel metal hydride rechargeable battery packs are available for Citadel VHF and UHF portables. The Fujitsu battery packs are rated at 1,700mAh with 7.2V and 12.0V assemblies.

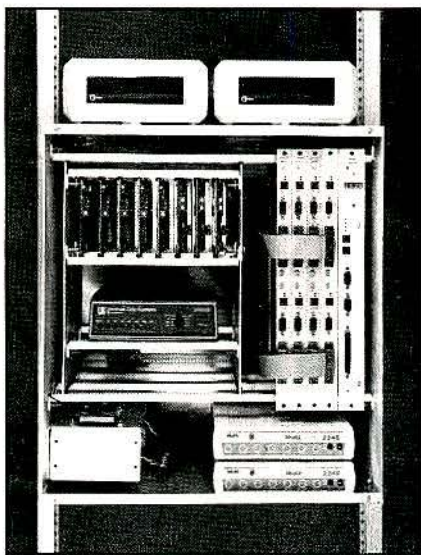
Circle (338) on Fast Fact Card

Propagation software 2.0 enhances processing speed

The propagation measurement and analysis software from SAFCO is available in version 2.0 based on Microsoft Windows 3.0 structure. The new structure with menu schemes increases the speed in processing data.

Circle (346) on Fast Fact Card

SMR network switch suits small operations



The Network Cube from AmeriCom fits four, six or eight ports and provides SMR operators with networking; interconnect; and over-the-air programming.

Circle (433) on Fast Fact Card

Second-generation mount includes secure hold

The second-generation Uni-Lok mount from SMC Electro-Mount includes a composite ball stud to hold the position securely and absorb vibration to mounted equipment.

Circle (339) on Fast Fact Card

Coaxial RF fuse holders hinder overload

The 50RF coaxial RF fuse holders offer protection from RF overload of attenuators and test instruments. Fusing levels are standard from 200mW to 3W. Some models are panel-mountable; fuses are replaceable from the front panel. A variety of connector options and configurations are standard for the JFW Industries fuse holders.

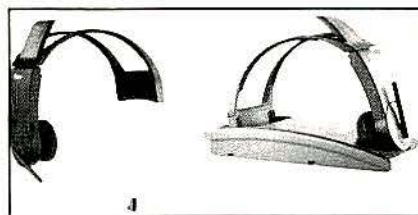


Circle (219) on Fast Fact Card

Cordless headset works 50 feet from base

A 900MHz cordless headset from Hello Direct includes a separate battery pack and radio transceiver that allows movement as far as 50 feet from the base. The unit boasts 32 channels and features an adjustable listening volume control and a noise-canceling mic.

Circle (352) on Fast Fact Card



CUSTOM DISGUISE ANTENNAS

STI-CO's two-way antennas are *exact* replicas of the AM/FM antennas supplied with your car—GM, Ford or Chrysler.

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Circle (65) on Fast Fact Card

New products

Repeater software interface changes frequencies remotely



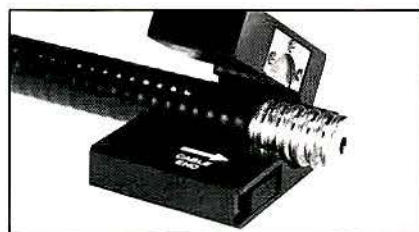
A remote channel access system for Fujitsu's Citadel in-band vehicular repeater allows the user of a hand-held unit to change the repeater's frequencies remotely. As many as 96 channels are accessible with the vehicular repeater. A digitized voice response confirms the selected channel is ready for use. The mobile repeater boasts a range of 148MHz to 174MHz in the VHF band and 450MHz to 480MHz in the UHF band.

Circle (345) on Fast Fact Card

Cable preparation tool fits 7/8-inch coaxial type

The Andrew cable preparation tool works with 7/8-inch foam dielectric coaxial cable for precise cuts in as little as 15 seconds. Model 222951 has a main blade and a second blade that scores the jacket at the exact dimension needed for LDF5 connectors.

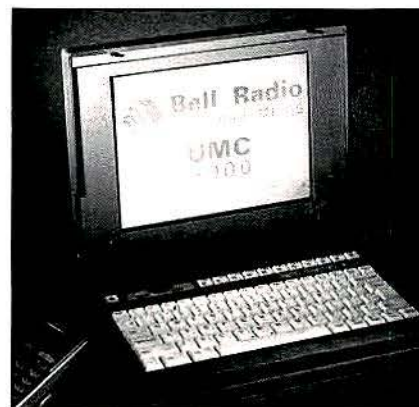
Circle (362) on Fast Fact Card



Mobile computer sports programmable function keys

The universal mobile computer 3000 from Bell Radiocommunications sports ruggedness and versatility with a heavy-duty LCD screen and 92 keys. The unit offers 12 programmable function keys and one protected emergency key. The computer has a quick connect and disconnect plug that handles power, two serial ports and one external audio port. The UMC-3000 supports a radio modem, fax, printer or other mobile-specific device.

Circle (306) on Fast Fact Card



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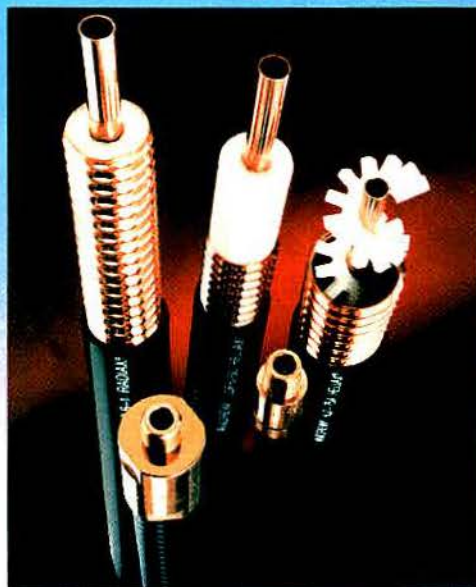
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MODEL NC4000 **MULTI-FUNCTION DTMF DECODER**

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Capable of controlling 10 outputs while sensing 10 external inputs.

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MICRO-MINIATURE DTMF ANI ENCODER
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Circle (68) on Fast Fact Card

New products

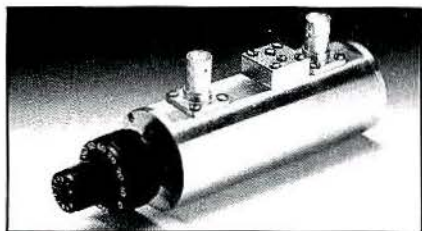
Hand-held receiver covers 500kHz to 1,300MHz

The AR1000XC hand-held receiver boasts 1,000 channels and a 500kHz-to-1,300MHz coverage range. The **Ace Communications** unit has 26 front-panel keys for programming 1,000 scan memory channels; and pairs of upper and lower limits for bands to be searched can be stored in 10 search memory locations.

Circle (313) on Fast Fact Card



Dual rotary attenuators come in 50Ω, 75Ω versions



Dual rotary attenuators from **JFW Industries** are available in 50Ω and 75Ω versions. Standard operating frequency is dc to 1,000MHz. The 50Ω units are available with BNC, N or SMA connectors. The 75Ω units come with BNC or F connectors.

Circle (276) on Fast Fact Card

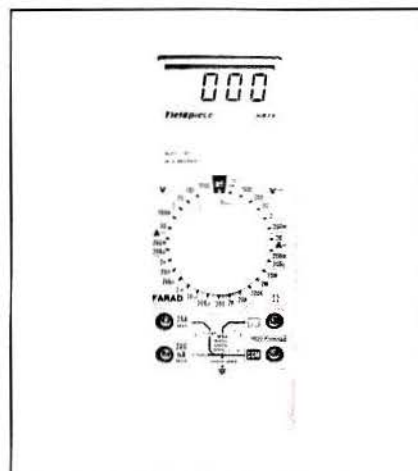
2.5W trunked hand-held boasts 14-system capacity

The 8565 2.5W 800MHz trunked hand-held from **E. F. Johnson** offers 14-system capability with 10 groups per system; system and group scan; alphanumeric display; and conventional operation with repeater talkaround. The portable provides DTMF keypad with interconnect operation with memory for eight speed-dial numbers and rugged construction.



Circle (264) on Fast Fact Card

Heavy-duty multimeters contain popular functions



Two full-sized heavy-duty digital multimeters from **Fieldpiece Instruments** contain the most-needed functions technicians use. The meters have an easy-to-use single rotary switch for function and range selection. Models HB71 and HB73 offer valox housing, O-ring seals, 600V fusing on current jacks and MOVs to protect against transients. The manual ranging models have 24 ranges in the popular formats, and model HB73 has six additional capacitance ranges to 200uF.

Circle (254) on Fast Fact Card

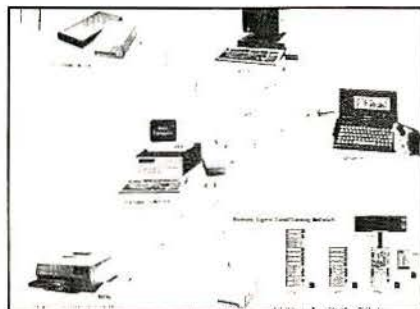
3dB gain antenna sports quick whip removal



The 3dB roof- and body-mount antenna from **Mobile Mark** suits UHF and VHF frequencies. The unit includes a quick disconnect function for fast whip removal and includes a spring-loaded center contactor and O-ring seal. Metal fittings are sealed and threaded. The antenna fits Motorola TAD/TAE products.

Circle (453) on Fast Fact Card

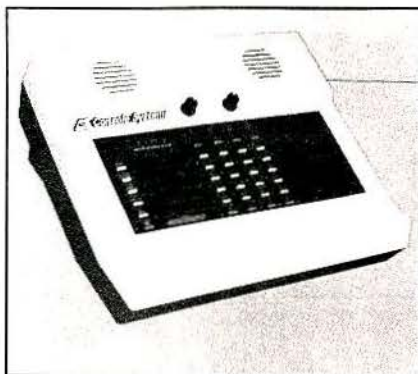
Packet radio modem transceiver provides secure transmission



Model 5100 spread-spectrum packet radio modem transceiver from **Solid State Electronics** provides secure two-way transmission and reception of digital data. The unit can be used as a wireless modem for PC communications within a building or as a data link to isolated or inaccessible areas.

Circle (431) on Fast Fact Card

Desktop radio control console suits 1- to 4-channel users



A self-contained radio control console from **Console Systems** suits users of one to four channels. The Minicom-IV console includes a micro-programmed logic sequencer; one system board; and select and unselect speakers. The unit includes three types of control signaling and operates on 12Vdc.

Circle (441) on Fast Fact Card

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- VOX-TM (voice-activated, with throat microphone)

Also available: The Series 3800 Intercom System, with mobile radio interface.

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Circle (70) on Fast Fact Card

New products

Ear mic transducer enables hands-free operation



The SWAT Ear-Mike suits law enforcement applications and includes a belt pack PTT switch that can be activated by the user's arm or a ring switch to trigger a transmission. The **Telex Communications** transducer features locking connectors and hands-free operation. Interface cables are available to match the unit with most portable radios.

Circle (308) on Fast Fact Card

Alpha paging adapter handles 24 input ports

The TAP-200 alphanumeric input port expander with improvements handles 24 ports and receives TDD devices on the same modem lines used for conventional alphanumeric paging. The **Hark Systems** device eliminates the need to install separate telephone lines for TDD compatibility.

Circle (430) on Fast Fact Card

10dBd omni broadband antenna supports duplex

Model PD10183 broadband antenna covers 806MHz-to-960MHz in three bands and enables duplex operations of cellular base stations on a single, high-gain omnidirectional antenna. The **Cel-wave** antenna incorporates center-fed copper radiating elements that are housed in a fiberglass radome.

Circle (455) on Fast Fact Card

Plug-in wiring set fits GE Delta radio

A plug-in wire harness for the GE Delta radio's tone signaling board is available from **Communications Specialists**. Model 01-1032 plugs into the radio on one end and into the TS-32P encoder-decoder on the other end.

Circle (464) on Fast Fact Card

Voice messaging system reaps software improvements

The addition of a software release for **Glenayre's** modular voice processing system allows enhanced radiopaging and subscriber features. One such feature, Secure Deposit, ensures that subscribers receive messages only from desired callers. Voice segmentation allows subscribers to purchase voice storage in five-hour increments. Administrative enhancements include expanded message statistics, improved screen layouts and agent access to a specified group of mailbox numbers.

Circle (463) on Fast Fact Card

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Circle (72) on Fast Fact Card

Billing data converter fits LTR repeater system

Model 494 universal accounting manager 19-inch rack-mountable billing data converter works with E. F. Johnson or Uniden logic trunked radio repeater sys-



tems in which there is a mixture of E. F. Johnson and Uniden interconnect controllers and interconnected **Zetron** model 49 trunking repeater controllers. The LTR billing data converter converts billing data into the Zetron format and acts as an airtime data storage buffer for the trunked system. It stores as many as 58,000 call records or as much as 194 days worth of airtime.

Circle (465) on Fast Fact Card

Digital encryption module fits tactical VHF radios

The RF-3995 digital voice encryption module fits **Harris** AN/PRC-117A main-pack transceiver and AN/VRC-94A series vehicular and base station transceivers. The module provides 16kbps digitally encrypted data and voice system. The system can be programmed for six user-defined key codes.



Circle (294) on Fast Fact Card

16-channel transceiver boasts DTMF keypad, scan

The PCS transceiver with scan includes a DTMF keypad for telephone interconnect, dual priority scan, LCD and wideband operation. The **Ericsson GE Mobile Communications** radio comes in a 5W version for highband, 4W for UHF and a battery-saving 2W unit. Power levels are PC programmable by channel. The portable radio meets military standard 810C and D.



Circle (371) on Fast Fact Card

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The Tait range of Fixed Station products incorporating modular receivers and transmitters are versatile, high performance units that form the vital link in communications under the most adverse conditions.

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Circle (73) on Fast Fact Card

New products

Display pager boasts multichannel synthesizer



The **Panasonic Vanguard 160** multichannel synthesized pager allows RCCs to offer regional paging through a single pager. The pager has three sets of frequency and cap code data. The unit includes a security code function; storage of as many as eight numeric messages and eight tone messages with a memory of 160 characters; non-duplicating memory; 20-character-per-message 12-digit LCD; and memory search, delete and recall. UHF, VHF and 900MHz versions are available.

Circle (438) on Fast Fact Card

8-channel 800MHz mobile has up to 15W output

Model 70-9150 eight-channel underdash mobile is programmable from 806MHz-to-825MHz and 851MHz-to-870MHz transmit; and from 851MHz-to-870MHz receive. The **Midland LMR** conventional radio offers adjustable RF output of 7.5W to 15W. The radio features built-in tone and DCS programmable capabilities; and one-button



selection of repeater talk-around.

Circle (391) on Fast Fact Card

Mobile command centers feature custom design



The **Commander** mobile command centers from **Skaggs Telecommunications Service** feature custom designs with radio, telephone, video, audio and power systems. Equipment is mounted in custom fabricated racks and consoles to fit a vehicle space and use requirements. Two-way radios may be selected for high or low VHF, UHF or aircraft frequencies.

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Circle (74) on Fast Fact Card

HIGH PERFORMANCE PRESELECTOR-PREAMP

The solution to most interference, intermod, and desense problems in repeater systems.



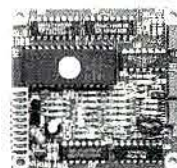
- 40 to 1000 Mhz tuned to your frequency
- 5 large helical resonators
- Very high rejection
- Low noise—high overload resistance
- 8 db gain—ultimate rejection >80 db
- GaAs fet option (above 200 Mhz)
- Cast aluminum enclosure
- N, BNC, and SO239 connector options

Typical rejection:

± 600Khz @ 145 Mhz: 28db	± 20 Mhz @ 800 Mhz: 65db
± 1.6 Mhz @ 220 Mhz: 40db (44db GaAs)	± 20 Mhz @ 950 Mhz: 70db
± 5 Mhz @ 450 Mhz: 50db (60db GaAs)	

AUTOMATIC IDENTIFIERS

- Up to 8 EPROM programmed messages
- Adjustable audio, speed & interval timer
- "ID over voice inhibit"
- Low power option
- Modular design
- Message selection via binary input—TTL levels
- Size: 2.7 x 2.6 x 0.7"



Model
ID-2B

The ID-2B provides required station identification without troublesome diode programming. The "ID over voice inhibit" circuitry allows for courteous operation by not allowing an ID until the next squelch closing.

ID-2B Wired/Tested \$99.95

ID-2B-LP Low Power \$109.95

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Circle (75) on Fast Fact Card

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- Greater than 84×10^9 year pseudo-random encryption sequence period
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- Easily passes through repeaters and voters
- Best recovered audio quality in the industry
- Selective Call (Individual & 3 Groups)
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- Stolen Radio Destruct & Triangulation/Monitoring of lost or stolen radios
- Requires U.S. State Department License for export

K TVS-2/Mic-Coder



Tactical Rolling Code Voice Scrambling Microphone

- Compatible with TVS-2 scramblers
- Durable microphone with backlit keypad
- LEDs: scramble mode light, call light, & transmit light

Q MTSS-M2



Full-Duplex Rolling Code Mobile Telephone Scrambler

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- Digitally controlled audio processing
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- Employs RJ45 connectors for simple installation in Cellular mobiles and portables
- Works with Midian MTSS-B series scramblers installed at IMTS or Cellular Switch
- Requires Keyloader programmer and U.S. State Department License for export

10 VPU-1



Smallest Simplex Inversion Scrambler

- Ultra-thin simplex inversion scrambler
- Single code scrambler
- Anti-aliasing input filter
- Crystal controlled for high stability
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- Available with flying leads or optional socket

J VPU-2



Subminiature Tunable Voice Inversion Scrambler

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- Six-pole tracking output filter
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Circle (434) on Fast Fact Card

Message repeater delivers digital voice storage



Model 19 Simplexor solid-state message repeater converts a simplex base station or mobile radio into a simplex repeater. The Zetron unit comes with 40 seconds of digital voice storage.

Circle (468) on Fast Fact Card

Vox noise-attenuating headset comes with throat mic

Model H7245 VOX headset with noise-canceling electret throat mic offers hands-free operation and works with most portable radios. The David Clark headset will not drain power from the radio.



Circle (435) on Fast Fact Card

Leather cases safeguard cellular portables



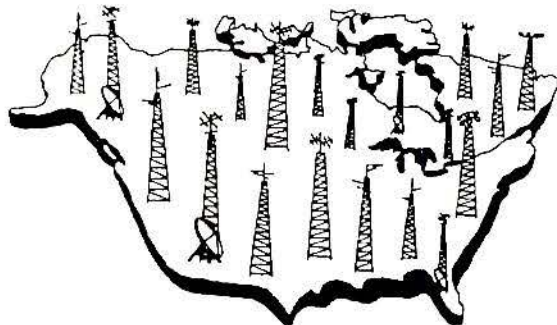
A deluxe line of leather cases for cellular portable telephones is available from Ora Electronics. The cases protect phones from damage.

Circle (214) on Fast Fact Card



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Circle (79) on Fast Fact Card

Book highlights dual-mode cellular

Dual Mode Cellular by Lawrence Harte discusses dual-mode cellular functions, design considerations and a systems perspective. The hard-covered book includes analog cellular, world cellular technologies and cellular system economics. *Wireless Communication Technology Resources* is a catalog describing the books, engineering software, seminars, market studies and training videos from Quantum Publishing.

Circle (381) on Fast Fact Card

Catalog features static dissipater

Lightning Prevention Systems' catalog describes the ALS-1000 static dissipater. It has been upgraded and meets UL-92 specifications. The publication features grounding and dissipater technology discussions.

Circle (251) on Fast Fact Card

Brochure describes voice storage option

Midland's voice storage and message relay option brochure describes features of the unit including two ways to avoid missing messages when users are away from their vehicles. In the **STORE** mode, the device operates as a "mobile answering machine" giving callers a prerecorded status announcement and storing the caller's message. In the **RE-LAY** mode, it works like a repeater to extend the talk-back range.

Circle (250) on Fast Fact Card

Book lists maritime frequencies

General monitoring, VHF frequency allocation charts, coast ship frequency cross reference charts and 220MHz marine frequencies are included in the *United States Maritime Frequency Directory*. The publication, by **Official Scanner Guide**, contains more than 27,500 listings by community and includes the 1991 ITU frequency allocation changes.

Circle (280) on Fast Fact Card

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Circle (82) on Fast Fact Card

Literature

Book explains radio frequency interference

"Radio Frequency Interference: How To Find It and Fix It" explains the mechanisms of electromagnetic interference (EMI) and provides solutions. Chapters provide background information about EMI fundamentals, dealing with neighbors, troubleshooting, filter performance and direction finding. The 256-page book is from **The American Radio Relay League**.

Circle (257) on Fast Fact Card

Book lists frequencies for public safety

Police Call lists frequencies used by all city and county agencies, state and federal agencies, highway maintenance, paramedics, forestry, aircraft and railroad users. It lists trunked 800MHz systems and radio codes. The books come in nine volumes and may be bought individually from **Falcon Direct**.

Circle (253) on Fast Fact Card

Directory lists industry standards

The ninth annual edition of the "Index and Directory of Industry Standards" (IDIS) is available from **Global Engineering Documents**. The IDIS includes 113,000 standards from 380 organizations. The standards are categorized by subject index, society and numeric listing, ANSI concordance tracks and society directory.

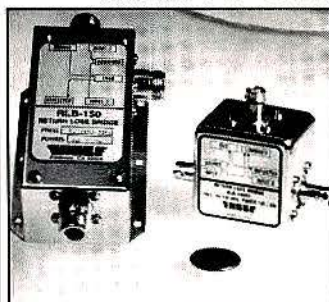
Circle (281) on Fast Fact Card

Study reports telco, cellular, PCS threat

A nationwide study of business and residential telephone users describes a need for a telephone service that would provide local telephone exchange services over a radio channel instead of copper or fiber optic cable. "Wireless Local Exchange Services: Opportunities, Competition and Strategies" is available from **Alexander Resources**.

Circle (255) on Fast Fact Card

Return Loss Bridges



Features

- Directivity: >50 dB typical
- Internal reference
- RF reflected port
- High power rating: 5 watts
- Swept SWR measurements
- Rugged construction
- .04 Mhz to 1.3 GHz

Return Loss Bridges are a low cost solution for swept SWR measurements. These bridges can be used with a spectrum analyzer/tracking generator or service monitor. Being a self contained unit, no external attenuators, amplifiers, comparators or detectors required. Easy to use: Connect generator to "source" port, analyzer input to "reflected" port. Set reference level with "load" port open, connect your device under test and take reading. Five watt power rating, unmatched in the industry, protects YOUR bridge from power coming down the feedline during antenna measurements at crowded sites. Rugged nickel plated brass enclosures assure excellent durability and shielding.

FREE application note, "Understanding the Return Loss Bridge", call and ask for it!

Application note covers the uses of return loss bridges such as: tuning antennas, receivers, cavities, duplexers, isolators, and pre-amps; fault location in transmission lines and multiple bay antenna systems; measuring impedance and structural return loss of coaxial cables. This note also discusses the relationship of VSWR, return loss and reflection coefficient in basic, simple to understand terms.

Following units are available from stock:

Model	Freq Range MHz	Directivity	Price
RLB150B1	.040 to 150	50 dB	\$259.00
RLB150N3A	5 to 1000	35 dB	\$289.00
RLB150N3B	5 to 1000	45 dB	\$349.00
RLB150N3C	5 to 1300	45 dB	\$395.00
RFT050NM2	DC to 3000 reference	40 dB	\$125.00
CIS050N2	Matching cable sets 2 ft	NA	\$ 40.00

Note: When purchased with a bridge the RFT050NM2 and CIS050N2 are \$95.00 total

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Circle (83) on Fast Fact Card

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Circle (84) on Fast Fact Card

Technicians' roles entail more than just repair

Technicians perform many tasks outside the realm of equipment maintenance and repair, according to respondents to the November 1992 "What Do You Think?" questionnaire as reported in these statistics, with multiple responses adding up to more than 100%:

DUTIES % THAT PERFORM THESE

REPAIR	96.0%
CALIBRATING TEST EQUIPMENT	36.6%
PHONE ORDERS	36.6%
PULLING PARTS INVENTORY	52.5%
TALKING TO CUSTOMERS/ PROSPECTIVE USERS	5.4%
OTHER	63.4%
NO RESPONSE	29.7%
	1.0%

Technicians spend various time on repair vs. other tasks, with most spending 31% to 70% of their time on repair.

Most technicians are willing to work overtime, if required. Readers report that most employers are willing to compensate them for overtime.

Other duties technicians report they handle include:

- "Building maintenance."
- "Communications engineering."
- "Coordinate service and preventative maintenance."
- "Counter sales."
- "Design mobile radio."
- "Field work that requires travel."
- "Installation, modification, field survey, field system maintenance."
- "Promote purchasing 'new.'"
- "Site engineering."
- "Software and computer maintenance."
- "Training."
- "Site analysis."
- "Technical support."

Job requirements vary depending on technician training and schooling level



Express yourself

Something bothering you? Want to sound off about it?

Need help that other readers might provide?

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Mobile Radio Technology
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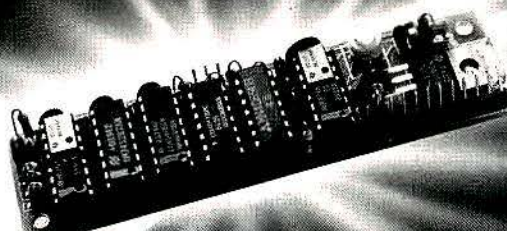
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Circle (85) on Fast Fact Card

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Feedback

and the size of the business. Some of the job criteria include:

- "Component level repair of electronic equipment, calibration, testing, etc."
- "Expect technicians to know it all. Must have thorough knowledge on varied items of a system. All of this for low wages."
- "General work tickets, parts sales;

technical questions answered, bench work and field work."

- "If it has a wire on it, the technician is responsible for it and should know how it works."
- "In order to stay current, a technician must know about analog, digital, computer and RF technologies."
- "Someone who enjoys the challenge that accompanies electronics and

troubleshooting. Must have knowledge of test equipment, all types of two-way and paging models, as well as a good sense of humor."

- "Installation and maintenance of data, phone, microwave and fiber optic."
- "Install and service VHF and UHF two-way radios; repair and calibrate test equipment; install and maintain telephone carrier equipment."
- "Knowledge of RF transmitters and receivers a must."
- "Mobile, portable and repeater repair. Paperwork is involved with recording repair and inventory. Running private shop."
- "Need FCC certification or equivalent to satisfy all requirements."
- "Responsibilities differ with the size of the shop. Those selling and servicing new equipment probably will find their service income getting smaller."
- "Requires both analog and digital skills, troubleshooting to component level. Technicians work on a wide va-



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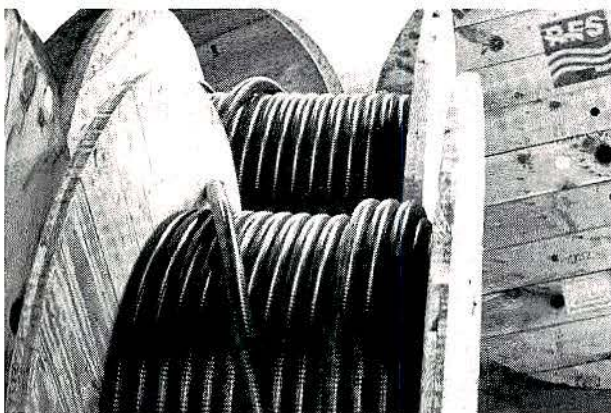
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Circle (88) on Fast Fact Card

- "Order and pull parts from stock"

[illegible]

- "Order parts. Install units."
- "In this rural shop, all technicians work on everything from school PAs to other communications equipment. We order parts. We climb towers. You name it; we do it."

- "Write test procedures. Evaluate systems performance. Recommend field and engineering changes." 



Circle (89) on Fast Fact Card



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Circle (90) on Fast Fact Card



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Circle (91) on Fast Fact Card

People



Singer



Strauss



Tompkins



Bobkoskie

Andrew Singer leaves Sinclair Radio Labs, Tonawanda, NY, as senior applications engineer to join Antenna Specialists, Cleveland, as product manager.

Appointments at Celwave, Marlboro, NJ:

David E. Strauss exits Motorola, Schaumburg, IL, as account representative to become Northeast regional manager at Celwave.

E. Duncan Tompkins II leaves Johnson Communications, Atlanta, as general manager to become manager of representative and distributor sales at Celwave.

Michael Bobkoskie departs Motorola, Schaumburg, IL, as zone manager and account executive to become international regional manager at Celwave.

Mal Gurian, most recently president of Cellcom Cellular, Fairfield, NJ, becomes chief executive officer at Universal Cellular, Anaheim, CA.



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1992

June

17-19—Virginia Tech Symposium on Wireless Personal Communications, Virginia Tech, Blacksburg, VA. Contact: Jack Lilly, 703-231-4849.

21-25—Utilities Telecommunications Council 44th Annual Meeting, Hyatt Civic Plaza, Phoenix. Contact: Rita Clark, 301-621-7802.

23-24—SMR Leadership Conference, ANA Westin Hotel, Washington, DC. Sponsored by American Mobile Telecommunications Association (AMTA). Contact: 202-331-7773.

July

19-23—Forestry-Conservation Communications Association, Toledo, OH. Contact: Don Pfohl, 602-644-3166.

August

9-14—Associated Public-Safety Communications Officers 58th National Conference, Washington State Convention Center, Seattle. Contact: 800-824-1850.

September

1-3—International Mobile Communications Expo/Fall, Georgia World Congress Center, Atlanta. Contact: 303-220-0600.

22-25—Mobile Communications Marketplace, Moscone Center, San Francisco. Contact: Telocator, 800-326-8638.



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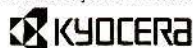
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Photocomm is an authorized distributor of the complete line of Kyocera Solar Power Modules

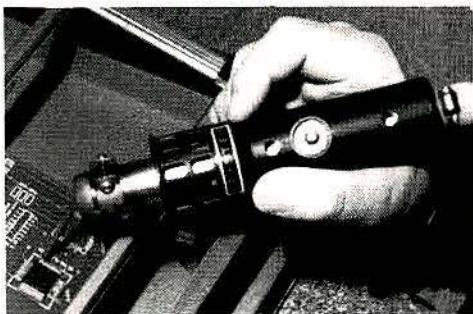


Circle (77) on Fast Fact Card

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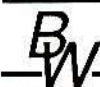


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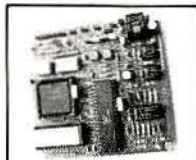
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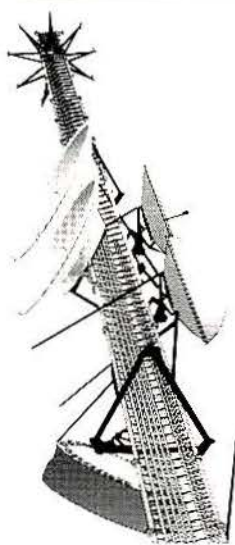


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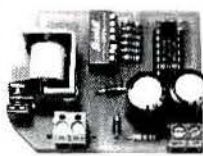
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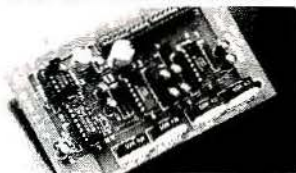
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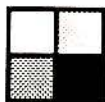
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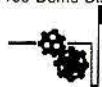
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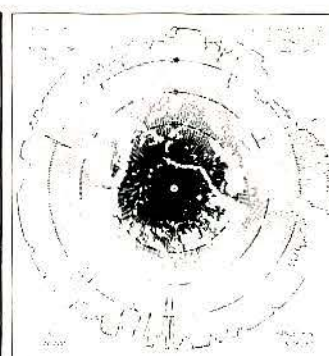
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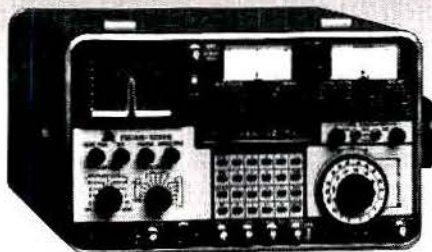
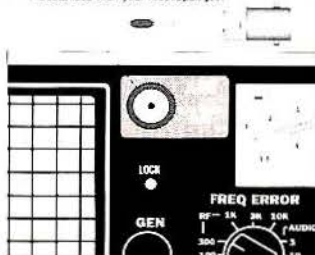
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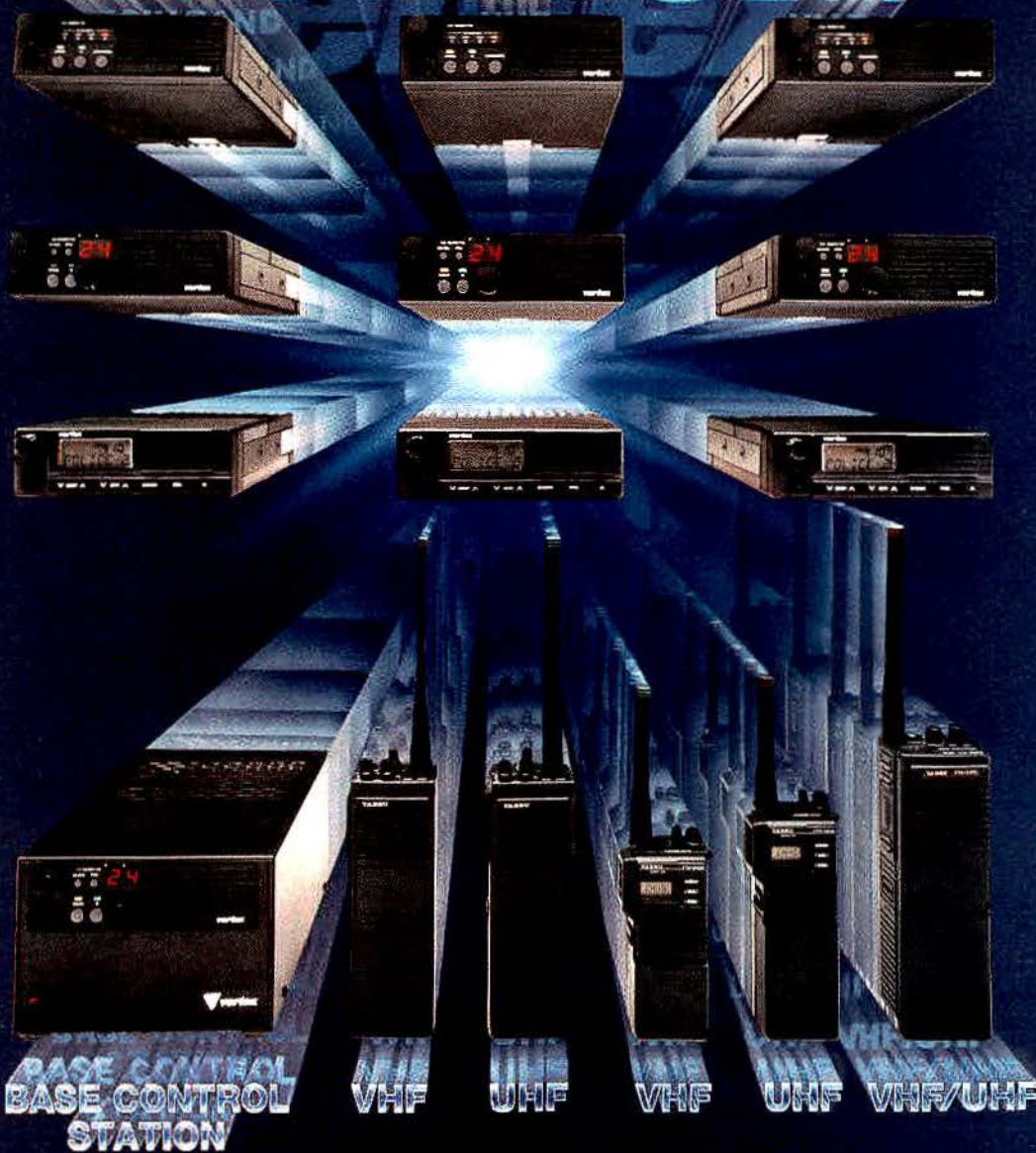


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Avtec Inc.	16	14	803-892-2181	Motorola Government	57	47	800-235-9590
Bee Electronics Inc.	76	71	708-345-0337	MX-COM Inc.	9	9	919-744-5050
Bomar	8,94	8,120	800-526-3935	New Mar	70	64	714-751-0488
California Radio	91		800-231-0103	Norcomm Corp.	74	68	916-477-8400
Carlson Communications	14	12	800-283-6006	Norton Engineering	99	131	703-938-5745
Cartwright Communications	55	45	513-489-1755	Omnicon Electronics	82	84	203-928-0377
Celwave	21	18	800-321-4700	Orbacom Systems Inc.	23	20	609-829-4455
Centurion International Inc.	3,92	5,111	800-228-4563	PanaVise Products Inc.	54	44	702-353-2900
Chargeguard Corp.	95	124	800-458-3410	Peacocks Radio & Wilds	103	140	800-232-7715
Cimarron Technologies	25	22	800-487-7184	Pekaar Communication Inc.	93	116	201-772-0704
David Clark Company Inc.	75	70	508-756-6216	Photocomm Inc.	87	77	303-988-8208
Coded Communications	15	13	800-228-6367	Pipo Communications	95	123	916-644-5444
Communications Associates	96	125	800-435-9313	Pirol, Inc.	47	38	219-936-4221
Communications Data Services	98	128	800-441-0034	Radiation Systems	42	34	708-298-9420
Communication Instruments	100	133	800-288-8223	Radio Express, Inc.	90	105	703-266-1928
Comsearch	102	139	214-680-1000	Radio Wholesale	90	107	800-53R-ADIO
COMTELCO Industries Inc.	40	32	800-634-4622	Ramsey Electronics	83,94	86,119	716-924-4560
Connect Systems Inc.	19	17	800-545-1349	RCW Distributing	92	110	800-726-9015
Control Signal Corp.	12	10	303-989-8000	Rocky Mountain Comms Inc.	98		303-526-5454
CPI Communications Inc.	60	50	800-869-9128	Rohn	59	49	309-697-4400
Cushcraft/Signals Corp.	17	15	800-258-3860	Sabre Communications	86	91	712-258-6690
Cushman/KNS Electronics	99	132	408-432-8100	Santa Fe Distributing	56	46	913-492-8288
Cybersym Control Sys.	98	130	703-268-5400	Schlumberger Instruments	13	11	800-225-5765
Datacom Inc.	50,76	41,72	217-222-0160	Securiton Company	83	85	408-263-6434
Data Signal Inc.	64	57	912-883-4703	Setcom Corp.	56	69	415-965-8020
Decibel Products, Inc.	73	93	214-631-0310	Shinwa Communications of America	48	39	800-627-4722
Eagle Wichita	82	83	316-942-5100	Shure Brothers, Inc.	69	63	800-25S-HURE
EMR Corp.	66	59	602-581-2875	Siemens Solar	18	16	805-338-6341
Ericsson GE Mobile Comms	41	33	800-GE1-2345	Sigtone, Inc.	58	48	800-525-8663
Falcon Tower Fabricators	92	109	915-658-7155	Skyline Antenna Mgmt.	101	137	203-684-4444
Freeman Engineering Assoc.	29	25	504-831-7785	SMC Electro-Mount	62	53	800-527-1079
Frequency Management	92	112	800-800-9825	Softwright	97		303-329-6388
FWT	63	55	800-334-1481	Solar Electric Specialties	80	79	707-459-9496
Gamber Johnson	72	66	715-344-3482	Sonic Communications Inc.	87	92	603-878-1944
General Communications	90	106	800-356-3200	Southern Computer Corp.	93	113	800-752-3571
GLB Electronics	78	75	716-675-6740	Standard Communications	43	35	800-767-6695
Henry Radio	81	81	800-877-7979	Sti-Co Industries Inc.	71	65	716-662-2680
Hewlett Packard	32A-B,33	28	509-921-4001	TAD Radio	22	19	509-328-1511
Hutton Communications	84,85	88,90	800-442-3811	Tait Electronics USA Inc.	77	73	713-984-8684
Hy-Q International	93	114	606-283-5000	Transcript International Ltd.	5	6	402-435-4400
ICOM America	35	29	206-454-8155	Trylon Manufacturing Co. Ltd.	80	78	519-669-5421
IFR Systems, Inc.	31	27	316-522-4981	TWR Lighting Inc.	102	138	713-973-6904
Industrial Comms & Elecs.	101	136	800-323-7212	Uniden Corp. of AM-MSG Inc.	39	31	817-354-8324
International Crystal Mfg.	78	74	405-236-3741	Unipage	49	40	800-367-2864
JaBRO Batteries Inc.	81	80	800-323-3779	Valmont Industries, Inc.	68	62	402-359-2201
Larsen Electronics	36-37	30	206-573-2722	VCP International Inc.	84,85	87,89	800-527-9366
Leathersmith	66	60	800-233-0440	Vega, A Mark IV Co.	1	4	818-442-0782
Logotronix, Inc.	95	122	800-442-4887	Vocom Products Corp.	60	51	800-USA-MADE
L&R Communications Ltd.	7	7	712-252-4101	WAVETEK	65	58	800-245-6356
Maxon America Inc.	28	24	816-891-6320	Western Towers	82	82	915-658-6539
Maxrad, Inc.	45	36	708-595-3933	Brian R. White, Co. Inc.	87	67	707-462-9798
				Yaesu USA	IBC		213-404-2700
				Zetron Inc.	52,53	94,43	206-820-6363

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